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ARTICLES

PERFORMANCE OF AERIAL SPRAY EQUIPMENT USED TO DISPERSE DDT AT ORLANDO, FLORIDA—SUMMARY *

L. H. SEBORA, C. C. DEONIER, C. B. WISECUP, C. N. HUSMAN, AND O. M. LONGCOY
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The dispersion of DDT oil solutions and water emulsions from airplanes created greater and more widespread interest than any of the other war time entomological problems investigated for the armed forces. The development of sprays and methods of aerial dispersal for the control of mosquitoes and other insects was an important contribution to the war effort. Potts (1939) and Whitten (1941) had previously employed airplanes for the application of sprays, but until the development of DDT this means of application was impractical for mosquito control.

Studies were made at the Orlando, Fla., laboratory of this Bureau, from 1942 to 1945, which involved the development of suitable equipment for dispersing DDT sprays, the proper concentrations for solutions, droplet-size range, rates of distribution, and effectiveness of sprays against various species. This paper presents a summary of the physical characteristics of the sprays, the effective swath widths, and the delivery rates obtained with the airplane spray equipment which has been studied by the authors.

* This work was conducted under a transfer of funds recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

† Sgt. L. H. Sebora, of the U. S. Army Air Forces, was assigned to the Orlando laboratory. Acknowledgment is made to Lt. Paul A. Dahm, of the U. S. Navy, and Lt. Robert Carter, of the U. S. Marine Corps, Cherry Point, N. C., for the opportunity to study the Greenfield model spray equipment; also to Lt. James Weatherell and Ens. T. S. Roberts, U. S. Naval Air Station, Banana River, Fla., who made possible the studies on the TBF.

The following agencies have cooperated with this Bureau in the development and evaluation of aerial spray equipment: Army Air Forces, Tennessee Valley Authority, National Defense Research Committee, Bureau of Medicine and Surgery of the U. S. Navy, the U. S. Coast Guard, the U. S. Marine Corps, and the Chemical Warfare Service.

METHODS OF OBTAINING DATA

Delivery Rate.—The delivery rate for any particular piece of equipment was the quantity of liquid discharged in a given time. This rate was usually expressed in quarts per minute, and was determined by placing a measured amount of material in the supply tank, flying the plane for 1 or 2 minutes, during which time a spray was being produced, and then measuring the material that remained.

Droplet-Size Range.—To determine the droplet-size distribution in the sprays produced by the aerial equipment, samples of the spray were caught on microscope slides coated with magnesium oxide. The slides were prepared by holding them in the smoke given off by burning magnesium turnings, the thickness of the coating depending on whether coarse or fine sprays were expected, since the layer of magnesium oxide must be slightly thicker than the radius of the largest droplet to be collected. The coated slide was held in the dense spray as it was discharged from an airplane flying into the wind at a minimum altitude (approximately 10 to 15 feet). The slide was moved about slowly in the spray to insure even distribution of the impinging drop-

lets. Replicate samples were made from repeated flights. The diameters of the craters of 100 droplets were measured on each slide sample, using a microscope fitted with an ocular micrometer. Selected reading of droplet craters was avoided by making random measurements over as large an area of the slide as possible.

Swath Width.—The minimum effective swath width was determined by exposing to a DDT spray containing a tracer dye (1) larvae of *Anopheles quadrimaculatus* Say in half-pint ice cream cartons containing distilled water, (2) petri dishes, (3) slides coated with magnesium oxide, and (4) 6 by 6 inch glass plates. These articles were placed on the ground at stations 20 feet apart and in a straight line at right angles to the prevailing wind. The airplane was flown at an altitude of 35 to 40 feet into the wind across the center of the line.

Two of the glass plates were placed side by side at each station. They were collected as soon as possible after the test flight, and the exposed surfaces were placed in contact with each other and the plates fastened together with Scotch tape. The plates were also protected from sunlight to prevent the dye in the spray solution from fading. The amount of tracer dye in the spray deposit on the glass plates was determined with a photometer. The values obtained from the photometer readings were translated into milligrams of deposit by use of a previously prepared graph of readings where known dilutions of the dye were used.

The size of the droplets falling at any station was determined from the magnesium oxide-coated slide at that station. A comparison of these results with the droplet size range previously determined gave valuable data on the distribution of the spray in relation to the line of flight.

To determine the amount of DDT deposit on the petri dishes, houseflies (*Musca domestica* L.) were exposed to the sprayed surface and the knock-down rate was recorded. A 24-hour reading was taken on the mortality of the *Anopheles* larvae in the half-pint cartons.

The swath width was determined from the mortality of mosquito larvae and adult houseflies and from the quantity of DDT, as shown by the deposits on the slides and plates, at the different stations.

FACTORS CONTRIBUTING TO EFFICIENT AERIAL DISPERSAL OF SPRAYS

The primary consideration in the development of aerial spray equipment for applying DDT solutions was that the equipment be so designed that the highest concentration of DDT used would be deposited uniformly in the area to be treated. To evaluate the uniformity of a spray pattern it was necessary to determine the effective swath width and the amount of dispersion that was being obtained with each piece of equipment. Both these factors are affected by the design and speed of each airplane, and by the location of the dispersion orifices in relation to the slip stream. Since dispersion of a liquid by spraying is inversely proportional to the size of the droplets, the solution to the problem would seem to be equipment designed to produce the smallest possible droplets. Actually this solution would reduce the efficiency of applying spray material from the air. This becomes apparent when the meteorological conditions and terrestrial environment existing at any given time and place of spraying are taken into consideration.

Since aerial spraying is carried out fairly close to the ground, the wind velocity, wind direction, and temperature conditions that exist there, especially those in the atmospheric layer immediately adjacent to the ground, also affect the deposition of the spray droplets. The temperature difference between heights of 2 meters and 0.3 meter indicates the lapse rate, with a positive reading indicating inversion (stable air) and a negative reading lapse (turbulent air). All these conditions, except inversion, which generally

exists only for a short time in the early morning and evening, are adverse to the deposition of small droplets (probably those below 100 microns in diameter). However, small droplets, which will remain airborne for a considerable time, may contact insects in flight. They are also desirable, when used in stable air, for penetrating jungle canopy and other foliage which would tend to obstruct the deposition of larger droplets on mosquito breeding places. Large droplets, by virtue of their mass, tend to overcome adverse atmospheric conditions and are therefore more easily controlled than small droplets. This advantage is counteracted by the fact that the predominance of large droplets in a spray reduces the efficient distribution of the spray solution.

The problem of producing an efficient aerial spray, in this endeavor, was also complicated by the armed forces' requirement of dispersing DDT solutions as efficiently as possible for all conditions that might be encountered by them. Therefore, equipment was developed which produced a spray with a wide droplet-size range, with the idea of overdosing sufficiently to compensate for any loss of efficiency at the extremes of the droplet size range. The delivery rates were adjusted so that each piece of equipment put out material sufficient to deposit 2 or 3 quarts of liquid per acre, depending on the speed and effective swath width of each type of airplane.

DISCUSSION OF EQUIPMENT AND RESULTS

Only the salient features of the equipment used in these tests, with regard to their performance in applying sprays, are briefly described.

L-4 (Piper Cub). VENTURI WITH FERN-TYPE NOZZLES.—The first aerial spray equipment developed in these studies was designed for the Piper Cub (Army L-4) airplane. The spray unit as released to the armed forces was known as the "Husman-Longcoy Spray Unit for the J3 Piper Cub," and consisted of a supply tank, a gear pump powered by a small wind-driven propeller, and a semiventuri with spray boom and nozzles, together with a cut-off valve, connecting hose, and fittings. (Husman *et al.* 1947.)

The venturi hung under the fuselage at the center of gravity of the plane. The six brass fern-type nozzles located on the trailing edge of the venturi had adjustable jets whose discharge impinged on wide angle conical breaker plates. The nozzles, fitted with No. 54 wire-gage orifice jets, delivered 11 quarts of oil spray per minute at a pressure of about 40 pounds per square inch. This equipment produced a spray containing droplets of various sizes, most of them being over 200 microns in diameter. The minimum effective swath width was 40 feet. Results of field tests using this equipment are given by Deonier *et al* (1945), Lindquist *et al.* (1945), and Wisecup *et al.* (1945).

In spite of this narrow swath width and the wide variation in mass distribution and droplet-size range created by this spray unit, it was widely used by our armed forces and served as a satisfactory expedient while work on what proved to be more efficient equipment was in progress.

BREAKER-BAR EQUIPMENT.—The breaker-bar equipment, together with the underwing spray boom and attached impinging bar, was originally developed for the Navy TBF airplane by C. N. Husman. The modification of this equipment for the Piper Cub (L-4) utilized the supply tank and pump assembly from the Husman-Longcoy unit. The spray was discharged through a row of orifices in two ½-inch pipes. The pipes, each 38 inches long and containing 24 No. 71 wire-gage orifices equally spaced along their lengths, are attached under the wings of the airplane with the orifices directed toward the rear of the plane. The spray material discharged from the orifices is impinged on one edge of a prismatic bar, which is situated ½-inch away from and directly opposite the line of orifices.

The droplet distribution, both as to number and mass, was similar to that

from the fern-type nozzles, which was to be expected as the basic principle is the same. However, by making changes in the pump assembly it was possible to double the pressure and produce a spray in which the larger drops were eliminated. The use of the more powerful pump was not practical for general field use, and it has not been recommended.

Placing the outlets under the wings produced two distinct spray clouds which tended to roll together and produce a swath 80 feet wide, double that achieved with the venturi. This increase in swath width required the delivery of twice the amount of material, and resulted in only half the flying to cover a given area.

L-5 (Stinson). SPRAY BOOM.—A spray boom equipped with modified fern-type nozzles was suspended beneath the fuselage of an L-5 without the venturi. A 4-bladed propeller was used which gave a pump pressure of 120 pounds per square inch. In other respects the equipment was similar to that for the Piper Cub.

The increased speed of this airplane (90 m.p.h.) as compared with that of the Cub (70 m.p.h.) and the greater pump pressure gave an increased break-up of spray but a swath width of only 40 feet.

BREAKER-BAR EQUIPMENT.—The breaker-bar equipment for the L-5 plane was similar to that for the Cub, except that 80 orifices were used to secure delivery of the 40 quarts per minute. This amount covered approximately a 75-foot swath with the 3 quarts of liquid per acre the Army desired. An effective swath of 110 feet was actually achieved by this airplane, and this swath interval could be used to secure the more commonly used dosage of 2 quarts of liquid per acre.

PT-17 (Stearman). VENTURI WITH FERN-TYPE NOZZLES.—A venturi with attached spray boom similar to but much larger than that for the liaison-type planes was developed for the PT-17. This biplane, with a 250 hp. engine, had greater power, appeared to create a greater down thrust of spray, and was nearly as maneuverable as the liaison-type plane.

The two propellor-driven pumps, mounted on the landing gear struts, produced a pressure of 120 pounds per square inch in the spray line. Twelve modified fern-type nozzles were required to deliver sufficient spray to disperse 2 quarts of liquid at 90 m.p.h. and an effective swath width of 80 feet. Swath-width studies under adverse conditions indicated that the spray cloud was frequently confined entirely to the slip stream and was then less than 80 feet wide.

The increased spraying pressure and greater power and speed of this plane produced a spray with a droplet-size range similar to that of the L-5 but a finer spray than that secured with the L-4.

BREAKER-BAR EQUIPMENT.—Breaker-bar spray booms similar to those developed for the L-4 and L-5 airplanes were designed for the PT-17 airplane. This spray unit used the same tank and pump system as the venturi unit, the venturi being replaced by a breaker-bar assembly under both lower wings. Each boom was 12½ feet long with 50 No. 70 wire-gage orifices and suspended 12 inches below the center of the wings. The fine spray and the effective swath width of 110 feet produced by this equipment, combined with an increased pay load as compared with the L-4 and L-5 series airplanes, makes it more desirable for dispensing insecticide solutions from the air.

In an endeavor to further atomize the spray, a strip of wire screen was attached behind the impinging bar. Preliminary trials indicated that many more small droplets were produced with the screen than without it, but no marked change in the mass distribution was evident. Less control of the swath was obtained with this attachment, and its use would be limited to the most favorable climatic conditions.

N2S-3 (Stearman). THE GREENFIELD MODEL SPRAY APPARATUS.—In cooperation with the U. S. Navy and the U. S. Marine Corps, the Greenfield model spray

apparatus on the N2S-3 airplane was evaluated by the Orlando laboratory and found to compare favorably with similar equipment in which a pressure system was used. In this apparatus the spray solution, supplied from a tank situated in the front cockpit, was fed by gravity through two pipes extending out about 3 feet and at right angles to the fuselage on each side of the airplane, midway between the wings and tail assembly (Dowden *et al.* 1945). The solution was dispersed from a series of rotating, wide-angle conical metal discs connected to the ends of the pipes on each side of the fuselage. The discs were rotated by the metal propellers attached to them. The flow of liquid was regulated by a control valve operated by the pilot.

The chief objection to gravity-feed equipment is, of course, that the delivery rate varies with the change in head of the solution in the supply tank. Although the abrupt ending of the tests prevented complete determination of the flow rate, it was apparent that a fairly constant discharge could be achieved by gradually increasing the outlet to compensate for decreasing head as the tank was emptied.

Swath width tests indicated that the two spray clouds, as they left the spraying discs, were in the turbulent air outside the slip stream of the fuselage and that the spray spread sufficiently to give an effective swath of 100 feet. At a delivery rate of 35 quarts per minute this plane would disperse 1.8 quarts of spray per acre.

The droplet-size range of the sprays from this equipment was similar to that from the pressure spray units on the same type of plane. This indicates that satisfactory atomization was being secured by the whirling discs throwing the liquid into the air without the assistance of pressure equipment.

This equipment had the advantage that suspensions could also be dispersed.

TBF (U. S. Navy).—The breaker-bar equipment for the TBF airplane was originally designed to be installed beneath the wing tips so that the plane could readily be reconverted for combat duty. This equipment has subsequently been redesigned for use on other types of aircraft. In the TBF the supply of spray material was carried in an auxiliary bomb-bay tank, and pumped to the booms by 4 electric booster pumps. Each 92-inch boom contained 19 orifices of No. 50 wire-gage size. The output of 62 quarts of liquid per minute dispersed only 1½ quarts per acre with a 150-foot swath at a flying speed of 130 m.p.h. (20° flaps). The longer spray booms and greater delivery of more recent equipment gave a swath width of 250 feet.

The atomization of the spray covered a broad range of droplet sizes, with only 5 per cent of the drops and 40 per cent of the mass occurring in the range above 200 microns.

Helicopter (Model HNS-1).—In cooperation with the U. S. Navy and the U. S. Coast Guard, an extensive series of tests were conducted with a light helicopter. A more complete report on the development of spraying equipment for this aircraft has been presented by Yuill *et al.* (1946a), and only the data relating to swath width, output, and droplet spectra obtained with the various types of equipment have been included here. It was evident that the air turbulence created by the whirling rotary blades definitely limited the swath from any spray equipment to a width of 60 feet with this plane.

A pump connected directly with the helicopter motor allowed a pressure of 150 pounds per square inch to be used for the sprays. Very fine break-up of spray was secured by using a group of TT8001 nozzles for much of the subsequent spraying of test plots. Comparative studies on coarse and fine sprays at different concentrations were made by Yuill *et al.* (1946b).

PERFORMANCE OF EQUIPMENT

Data were obtained on (1) the performance of the Husman-Longcoy spray

TABLE 1. Droplet-size Range Obtained with Various Types of Aerial Spray Equipment.

Type of Plane and Equipment	Pressure (Pounds)	Type of Distribution	Percent of Droplets of Indicated Diameter								
			10-40 microns	41-100 microns	101-160 microns	161-220 microns	221-280 microns	281-340 microns	341-400 microns	401-460 microns	461+ microns
L-4 (Piper Cub):											
Venturi with fern-type nozzles (54 gage)	40	Number	6	37.0	20.0	17.0	7.0	5.0	4.0	2.0	2.0
		Mass	<0.1	2.0	7.0	12.0	14.0	15.0	18.0	14.0	18.0
Breaker-bar (71 gage)	70	Number	16.0	45.0	17.0	10.0	7.0	2.0	2.0	1.0	1.0
		Mass	0.14	3.5	7.4	10.4	17.5	8.4	17.4	14.9	20.4
	150	Number	0	42.1	36.8	15.5	1.8	1.8	1.8	0	0
		Mass	0	3.3	19.9	33.5	7.5	14.6	21.2	0	0
L-5 (Stinson):											
Spray boom with fern-type nozzles (60 gage)	45	Number	8.0	41.0	32.0	15.0	2.0	2.0	0	0	0
		Mass	0.14	7.2	27.2	35.9	10.7	18.5	0	0	0
Breaker-bar (71 gage)	120	Number	5.4	64.3	26.7	2.7	0.9	0	0	0	0
		Mass	0.32	25.6	50.9	13.0	10.1	0	0	0	0
PT-17 (Stearman):											
Venturi with fern-type nozzles (54 gage)	100	Number	11.0	36.0	37.0	11.0	4.0	1.0	0	0	0
		Mass	0.2	5.8	31.4	27.4	23.9	11.2	0	0	0
Breaker-bar (70 gage)	120	Number	5.0	43.0	31.0	16.0	5.0	0	0	0	0
		Mass	0.14	10.3	26.5	40.9	22.0	0	0	0	0
Breaker-bar screen (70 gage)	120	Number	20.9	54.9	16.3	5.0	2.4	0.5	0	0	0
		Mass	0.5	12.6	31.9	6.0	49.5	<.1	0	0	0
N2S-3 (Stearman):											
Greenfield model spray apparatus	Gravity	Number	2.0	54.0	29.0	11.0	3.0	1.0	0	0	0
		Mass	0.05	11.2	57.3	35.0	15.8	10.7	0	0	0
TBF:											
Breaker-bar (50 gage)	25	Number	24.0	49.0	16.6	5.6	3.0	0.9	0.9	0	0
		Mass	1.0	15.0	24.0	18.0	18.0	11.0	13.0	0	0
HNS-1 (Helicopter):											
TT8001 nozzles	150	Number	23.1	61.5	11.5	2.3	0.8	0.8	0	0	0
		Mass	1.1	24.2	29.4	12.7	11.9	20.6	0	0	0
Breaker-bar (80 gage)	150	Number	18.8	54.1	17.7	6.2	2.1	1.0	0	0	0
		Mass	0.6	12.9	23.8	25.6	21.6	15.8	0	0	0
Fern-type nozzles (70 gage)	150	Number	7.7	53.4	22.3	8.7	2.9	1.9	0	1.9	0
		Mass	0.5	3.3	6.4	6.4	5.8	7.0	0	21.4	49.6
Exhaust spray (fishtail stacks)	15	Number	11.0	55.0	20.0	12.0	1.0	1.0	0	0	0
		Mass	0.3	13.4	21.7	44.0	6.4	14.2	0	0	0

unit and modifications of this equipment on a Piper Cub (L-4) and Stearman (PT-17), (2) a nozzle boom without the venturi on a Stinson (L-5), (3) underwing booms with impinging bars (breaker-bar) on the L-4, L-5, PT-17, TBF, and an HNS-1 helicopter, (4) the Greenfield model spray apparatus on a Navy Stearman (N2S-3), (5) nozzle boom with both modified fern-type nozzles and TT8001 nozzles on the helicopter, and (6) an exhaust-generated spray from the helicopter.

The data on the droplet size ranges are presented in Table 1. The type of distribution is given as percentage of droplets by number and by mass within the various micron ranges. Table 2 presents the data on a number of nozzles or orifices which were used to give the

TABLE 2. Performance of Various Types of Equipment on Airplanes Tested at Orlando, Fla., 1944–45.

Type of Plane and Equipment	Orifices		Delivery (Quarts per Minute)	Air Speed (M.p.h.)	Swath (Feet)	Indicated Coverage (Quarts per Acre)
	Number	Gage				
L-4 (Piper Cub):						
Venturi with fern-type nozzles	6	54	11	70	40	2
Breaker-bar	48	71	22.4	70	80	2
L-5 (Stinson):						
Spray boom with fern-type nozzles	8	60	16	90	40	2.2
Breaker-bar	80	71	40	90	80	2.8
PT-17 (Stearman):						
Venturi with fern-type nozzles	12	54	29	90	80	2
Breaker-bar	100	70	40	90	110	2
N2S-3 (Stearman):						
Greenfield model spray apparatus			35.2	90	100	1.8
TBF:						
Breaker-bar	38	50	60	132	150	1.5
Helicopter (HNS-1):						
Spray boom—TT8001 nozzles	18		13.6	60	60	1.85
Fern-type nozzles	8	70	6.4	60	60	.85
Breaker-bar	48	80	16.4	60	60	2.3
Exhaust spray (fishtail stacks)	24		20.4	60	60	2.8

indicated delivery rate, and the effective swath width that was obtained with the given equipment on the designated airplane, together with the indicated deposit of liquid in quarts per acre.

Experiments were conducted with several types of spray apparatus for dispersing DDT solutions by using the exhaust from small airplanes. Dispersion was accomplished by injecting the solution into an extension of the exhaust pipe. Preliminary tests with this type of equipment on airplanes and extensive studies with a highly developed type of equipment on a helicopter (Model HNS-1) revealed deficiencies which made further developments along this line inadvisable. One serious disadvantage in this method of dispersing DDT petroleum-oil solutions is the inefficiency due to the partial vaporization of the solution to an ineffective smoke, the amount being inversely proportional to the distance of the point of injection from the airplane engine. The spray droplets are so small that their effectiveness is negligible against larvae

under all but the most favorable inversion conditions.

In cooperation with the U. S. Navy and the Army Air Forces Board studies were made on exhaust-generated sprays from equipment developed at the University of Illinois by H. F. Johnstone and coworkers. This equipment was designed to spray droplets about 5 microns in diameter. However, a wide range of droplet sizes could be obtained by changing flow rates of spray solution and power settings of the plane. Solutions containing 20 per cent of DDT were used which greatly increased the pay load over that possible when 5 and 10 per cent DDT solutions were used. This equipment was tested on the Navy TBM and the Army C-47. The exhaust-generated sprays were so fine as to require inversion to obtain the best results. They were more rapid in their action against adult mosquitoes than the coarser sprays. The equipment was rejected by the Navy as too complicated. Units adapted to the exhaust of a Stearman biplane having 450 hp. motors were reported (Metcalf *et al.* 1945) as being very satisfactory.

Simpler means of dispersing insect sprays from combat aircraft have been devised. The early work was done with M-10 tanks of the Chemical Warfare Service (Jones *et al.* 1945). The Army Air Forces Board later developed equipment utilizing the auxiliary bomb-bay tanks with simple valve controls and gravity feed to streamline grids and discharge pipes on C-47 and B-25 airplanes. Spray particles of 300 microns or less in diameter could be obtained.

The efficiency of the exhaust-generated sprays having a particle size of 50 to 100 microns, as compared with the gravity-feed streamlined discharge pipes, which gave droplets of approximately 300 microns, was the subject of extensive studies. The simple discharge pipes on a B-25 were satisfactory for dispersing concentrated sprays in dosages as low as 1½ pints per acre. At a dosage of 0.3 pound of DDT per acre the coarse sprays were found to be as effective as the fine sprays. The use of combat aircraft with high air speeds is practical only for military operations requiring treatment of large areas.

DDT sprays were effective against insects over a wide range of droplet sizes. At the dosages that have been used, control has been obtained regardless of the type of spray. There is probably no ideal particle size. The desirable droplet size will depend upon the insect to be attacked, the climatic conditions, and the environment of the insects. Thus far the most practical approach has been to have a range of droplet sizes that can be controlled under the most adverse conditions encountered.

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OBSERVATIONS ON MOSQUITO AND MALARIA CONTROL IN THE CARIBBEAN AREA

Part I—Suriname [1]

H. H. Stage [2] and D. C. Geijskes [3]

An opportunity to visit several entomologists and malarialogists representing mosquito and malaria control organizations was presented the senior author in March and April of 1946. The observations reported here were made in the course of extensive tests on the effectiveness of water-dispersible DDT residual sprays as a mosquito-control agent in the jungle of Surinam at Moengo.

The climate of Surinam is typical of low-lying coastal areas of the Tropics. The temperature averages about 81° F., with a range of only 14°. The heat is relieved somewhat by the trade wind, which blows almost constantly from the sea southwestward. The relative humidity averages about 84 per cent. There are four fairly well-defined seasons based on rainfall, which averages about 92 inches annually. The big rainy season lasts from March till August with an average of 10 inches of rainfall monthly, the big dry season from September until November with a monthly rainfall of about 4 inches. In December the rains begin again and they last through January, when it dries up until March.

Surinam, or Dutch Guiana, has a registered population of about 175,000, a third of which live in the capital, Paramaribo. One of the surprises greeting most visitors to Surinam is the number of nationalities represented. The true aborigines are the Indians who live mostly in temporary villages in the higher and drier bush. The Bush Negroes are pure descendants of the African black slaves who escaped from the plantations and settled along the upper rivers. The Surinamers, sometimes called creoles, a more or less mixed race, are descendants of the slaves brought to Surinam 200 to 300 years ago, Portuguese and German-Jews, and early Dutch settlers. Asiatics from India, China, and Java have been brought in as laborers. Western Europeans, largely Dutch, are also well represented.

Agriculture in Surinam is somewhat conducive to mosquito breeding. The hand-worked rice fields are prolific breeding places of *Anopheles aquasalis* Curry, *A. oswaldoi* Peryassu, and other species

[1] Surinam (English form), or Dutch Guiana.

[2] Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture.

[3] Agricultural Experiment Station, Paramaribo, Surinam.

(Fig. 2). Relatively small areas of fallow-flooded cane fields also support an anopheline population, although, fortunately, they do not breed *A. darlingi* as do the comparable cane fields only a few hundred miles westward in British Guiana. Most fields and plantations are ditched to provide drainage during the wet seasons. These ditches, or trenches as they are called, also support large and varied populations of mosquitoes.

There have been greater and lesser epidemics of malaria in Surinam, but the disease furnishes a constant threat to any who may venture into some parts of the savannahs and in the bush of the interior (Fig. 1). There is little malaria around Paramaribo and the coastal area except in occasional localities.

Filariasis is seen commonly on the streets of Paramaribo among the Surinamers. It does not seem to occur among the Bush Negroes and Indians of the savannah and bush areas, no doubt because of a lack of suitable breeding places for its vector, *Culex quinquefasciatus* Say.

These two diseases and the susceptibility of a varied population offer a combination of great concern to the industrial and agricultural future of Surinam. There is also speculation as to the source of these diseases. No doubt the black slave brought potent strains of malignant *Plasmodium* from his native Africa, and perhaps some filariasis as well. The Javanese and British Indians may also have brought in their peculiar strains of malaria. With these combinations of peoples and parasites we wonder that the epidemics of these mosquito-borne diseases were not more serious than have been recorded.

MOSQUITOES OF SURINAM

The mosquito population of Surinam is an extremely varied one. Bonne and Bonne-Wepster (1925) list over 130 species as probably occurring there. Of these, they list *Anopheles aquasalis, A. apicimacula,* D. & K., *A. mediopunctatus* Theo., *A. peryassui* D. & K., and *A. argyritarsis* R.-D. The last species undoubtedly is what we now know as *darlingi* Root.

Aedes aegypti (L.), the yellow-fever mosquito, and *Culex quinquefasciatus,* the transmitter of filariasis, are common everywhere in the villages. Bed nets and insecticide sprays are frequently in evidence. Recently one of us (Geijskes [4]) reported the presence in Surinam of *Anopheles pessoai* Galvao & Lane and *A. shannoni* Davis, two hitherto unknown species in the colony, whereas no specimens of *A. darlingi* were captured. In fact, the collections of anophelines in and around Moengo were greatly different than those reported twenty years previously by Dr. Bonne and his wife.

During these twenty years a considerable change has taken place in the ecological relations of Moengo and its environs. From a small settlement in the deeply shaded jungle, Moengo, now a village of about 1500, has become a veritable island of civilization. Epidemics of greater or lesser severity flourished during the '20's. At that time *Anopheles darlingi* (*argyritarsis* of Bonne and Bonne-Wepster), a particularly effective transmitter of malaria, must have been common. Close by, small settlements of Bush Negroes furnished a ready reservoir of *Plasmodium.* Gradually the jungle was pushed back by engineers who came to mine the rich deposits of bauxite. The Javanese aided in reclaiming the jungle and have cultivated small patches of ground for growing rice, cassava, bananas, tayer, and other crops. There is some reason to believe that that vicious carrier of malaria, *A. darlingi,* may have been driven beyond flying distance of Moengo by a conversion of its preferred shady breeding places into sunny areas conducive to the breeding of other anophe-

[4] Geijskes, D. C. 1946. Notes on the Neotropical Anophelinae in Moengo, Surinam. MOSQUITO NEWS, 6(3):113–118.

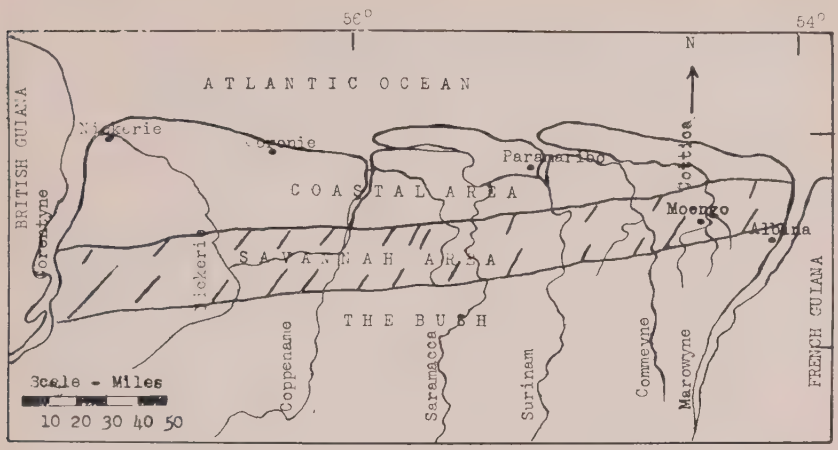

FIG. 1. The coastal area of Surinam is swampy and has a clay soil. South of the coastal area is the savannah, a more or less sandy belt and somewhat higher ground. Still farther south is the bush country. These areas are densely covered with a wide variety of plants and trees. The number of species is enormous. Indeed, the plant population of any acre is so varied that of the individual plants there may be not more than 5% of any one species.

FIG. 2. A typical rice paddy in which each rice plant is transplanted by hand. A grove of banana plants in the background.

lines which do not harbor the parasites of malaria. These ecological changes may or may not have been responsible for radical changes in the pH of the water, but on this point we have no information.

Few Indians live in this general area and so present no problem, but there are villages of Bush Negroes on every side. The Moengo authorities have taken steps to prevent these people from remaining within the village after dark. This practice undoubtedly is a great aid in keeping malaria to a minimum. The situation calls for the utmost vigilance in Moengo, however, because all the conditions necessary for a severe epidemic of malaria are ever present in the neighborhood.

Malaria transmission in the jungle of Surinam is due largely to the presence of *Anopheles darlingi*. This mosquito breeds mainly in shaded swamps overgrown with aquatic vegetation along the upper rivers in the interior. We think this explains the badly infected Bush-Negro villages, which are always situated on the banks of the rivers, whereas the Indians living in the drier savannahs suffer much less with malaria.

Severe outbreaks of pest mosquitoes often occur in northwestern Surinam in the districts of Coronie and Nickerie. There *Anopheles aquasalis* is very common, but curiously enough malaria is not present. In fact these districts are the healthiest in the colony. There are reports that severe malaria epidemics have occurred in northwestern Nickerie. These epidemics may have been caused by a temporary influx of *A. darlingi* from the upper river, or by the transportation of *Plasmodium* from the interior by bush laborers coming home in large numbers within a short period of time and infecting the *A. aquasalis* breeding there.

Although Surinam and British Guiana are similar in climate, topography, and agriculture, there is not a comparable occurrence of malaria in the two countries. Malaria is much more disastrous in British Guinana than it is in Surinam, because *A. darlingi* enters the coastal area of British Guiana in contrast to its absense in Surinam.

"INFLUENCE OF NATURAL WATERS ON THE EFFECTIVENESS OF DDT AS A MOSQUITO LARVICIDE"

(Copied from Bulletin of the Army Medical Department, Vol. IV, No. 6 (Dec., 1945), pp. 633–634.)

"Suggestions have come from the field to The Surgeon General's Office that the chemical constituents in natural waters might influence the effectiveness of DDT as a mosquito larvicide. To test this possibility, studies were carried out by the Fourth Service Command Laboratory at Fort McPherson, Ga. The kill of early fourth instar *Anopheles quadrimaculatus* larvae and of third instar *Aedes aegypti* larvae in various test waters was compared to that in a standard water. For *A. quadrimaculatus* larvae the standard water was distilled water raised to a pH of 8.0 with sodium carbonate; for *A. aegypti* larvae it was distilled water with a pH of 6.8. The standard amounts of DDT used were 0.0015 and 0.03 parts per million for *A. aegypti* and *A. quadrimaculatus*, respectively. These amounts of DDT killed from 70 to 100 per cent of larvae in forty-eight hours in the standard water.

"The test waters consisted of thirty-six samples of natural waters obtained from various locations in the Fourth and Eighth Service Commands and also synthetic waters made by adding to distilled water varying amounts of single chemicals commonly found in natural waters. An attempt was made to test natural waters with widely different chemical compositions. The findings in the laboratory were confirmed by tests made in the field.

"The conclusion reached from the studies was that no material in solution in natural waters interfered with the forty-eight hour kill of mosquito larvae by DDT provided that the proper amount of DDT for the particular species of mosquito was applied."

EXPERIMENTS WITH WEED-KILLERS AGAINST SALT MARSH PLANTS WHICH HINDER MOSQUITO CONTROL OPERATIONS*

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Mosquito control on the New Jersey salt marsh has long been hampered by dense vegetation growing along ditches or over the entire marsh. This is particularly true in the northeastern part of the state where the tall foxtail grass, *Phragmites communis,* grows to a height of 10 to 15 feet. Another troublesome plant which is more abundant further south in the state is the salt marsh elder, *Iva oraria.* When this plant invades a salt marsh it is first found along ditches and from there may spread over the entire marsh.

In September 1945 experiments were undertaken with weed-killers to destroy these plants or inhibit their growth. The weed-killer known commonly as 2,4-D† (2,4-dichlorophenoxyacetic acid) was tested in these experiments along with several other materials. The initial experiments were promising. Though the foxtail was not killed, severe injury resulted from the use of 2,4-D and "Ammate" (ammonium sulfamate). Ammonium sulfate and a material containing dinitro-ortho-cyclo-hexyl-phenol were not effective. On the salt marsh elder, dilutions of 25 and 50 grams of a 2,4-D powder in 2½ gallons of water applied to the leaves of the plants growing on 1000 square feet of area killed the plants, though at the lower dilution a few plants at one end of the plot survived. Probably these were not sprayed completely. In 1946 a few new plants, apparently from seeds, appeared in the treated area.

The success of these tests led to more extensive experiments in 1946, which are summarized briefly. These tests were conducted with the cooperation of several of the New Jersey Mosquito Extermination Commissions.

Treatments of Salt Marsh Elder

Tests of 2,4-D were made against the salt marsh elder on the Cheesequake Meadow in Middlesex County. Materials used included (1) the sodium salt containing 70 per cent 2,4-D; (2) the alkanol amine salt containing 20 per cent 2,4-D; and (3) a miscible oil preparation containing 12 per cent of the methyl ester of 2,4-D. These materials were applied to the plants at concentrations of 500, 1000, and 2000 ppm of 2,4-D on May 20. A second set of plots were sprayed at concentrations of 250 and 500 ppm on June 28. Applications were made with a knapsack sprayer. The leaves were wet thoroughly with a fine mist. In both cases the day was warm and rain did not occur for more than four hours after treatment. All treatments on both dates killed the salt marsh elder except in a few places where single plants were apparently sprayed poorly. Death of the plants occurred one to three weeks after treatment, preceded by the characteristic curling and twisting of leaves and twigs. In August new growth was not appearing on any of the plants, and it is believed that roots as well as aerial portions of the plant were killed, even at the low dosage of 250 ppm of 2,4-D. The usual concentration recommended on weeds is 1000 ppm.

Tests in Atlantic County against the salt marsh elder, produced similar results.

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† 2,4–D materials used in these tests were furnished by the Dow Chemical Company, Midland, Michigan, and the Ammate was furnished by E. I. du Pont de Nemours & Company, Wilmington, Delaware.

TREATMENTS OF FOXTAIL GRASS

Tests of 2,4-D on foxtail grass were made at Seidler's Beach in Middlesex County. Materials used were the same as those applied on salt marsh elder. One-quarter acre plots were sprayed on May 23 with the three materials at 500, 1000, and 2000 ppm. A power sprayer developing 200 pounds pressure was used in making applications, and spray was applied at the rate of 100 gallons per acre. At the time of spraying the grass had already reached a height of 4 to 6 feet.

No appreciable damage resulted from the application of either the sodium or alkanol amine salts of 2,4-D. However, the miscible oil prepartion containing 12 per cent of the methyl ester of 2,4-D had marked effects on the plants. At 500 ppm this material stopped growth of the grass by killing the growing tips. A month after spraying, the plants were shorter than when they were sprayed. The reduction in height was due to the dying of the tips of the plants. Severe injury to the whole plant resulted when 1000 and 2000 ppm were used. Leaves turned brown, stems were weakened, and lodging of the grass resulted. Injury appeared more quickly and was more severe when the 2000 ppm concentration was used.

Additional plots were treated on June 27 with the miscible oil preparation. At this time one-eighth acre plots were sprayed with 500, 1000, and 2000 ppm of the miscible oil preparation and one half of each of the original plots was resprayed with the same concentration used on May 23. Ten days later plants were showing injury. At 500 ppm, growing tips of nearly every plant were dead; at 1000 ppm, leaves were dead or severely injured; at 2000 ppm, the entire plant had turned brown. On the areas which were sprayed a second time new injury was evident in all plots. However, there was no sharp line of demarkation between the halves of the plots which had received one and two spray applications.

"Ammate" was applied on June 27 using 1 pound and ½ pound of the material per gallon of spray. Applications were made at the rate of 100 gallons per acre. Immediate burning of foliage resulted but plants were not killed.

Applications of 2,4-D mixtures to small plots in Atlantic County showed effects comparable to those obtained in Middlesex County.

Further observations are necessary to determine whether or not foxtail was killed by the 2,4-D applications. However, it is evident that the foxtail grass is severely injured by an application of a miscible oil preparation containing 2,4-D. Possibly an early season application of the material would kill the plant or prevent it from growing more than one or two feet high.

SUMMARY

Studies were made of the effect of 2,4-D (2,4-dichlorophenoxyacetic acid) on the salt marsh elder (*Iva oraria*) and foxtail grass (*Phragmites communis*). Materials used were as follows: (1) the sodium salt containing 70 per cent 2,4-D; (2) the alkanol amine salt containing 20 per cent 2,4-D; and (3) a miscible oil preparation containing 12 per cent of the methyl ester of 2,4-D. The materials were sprayed on foliage as a fine mist at the rate of about 100 gallons per acre. Salt marsh elder was killed by all of these materials when used at 250, 500, 1000, or 2000 ppm. The miscible oil preparation severely injured foxtail grass. Growing tips of the grass were killed by 500 ppm of the material, and more severe injury resulted from 1000 and 2000 ppm. Further observations will be necessary to determine whether or not these plants have been killed.

THE POSSIBLE ENDEMICITY OF *ANOPHELES ALBIMANUS* IN FLORIDA*

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Anopheles albimanus Wiedemann, the most important vector of malaria in the Caribbean region, has been recorded from Florida several times. Gardner (1904) first reported the occurrence of this species in the United States on a basis of collections made by MacDonell in Key West. King (1937) discussed MacDonell's findings and included notes covering these data.

MacDonell's collection consisted of 2 male and 129 female *A. albimanus* taken from a limited section of Key West between July 29 and August 20, 1904. Most of these specimens were taken in stables, although a few were found in residences. No larvae were discovered. According to King, it was suggested by MacDonell that the captured adults were the progeny of a single female, possibly brought by a vessel from Vera Cruz, Mexico. In an abstract of the discussion following this paper, MacDonell stated, "My search was so intensive and thorough that I have reason to believe that I exterminated this breed. In so doing, I probably checked what otherwise might have been an invasion of the Keys and the mainland by the chief vector of malaria in the West Indies."

Griffitts (1931) reported taking *A. albimanus* during inspections of airplanes arriving in Miami from foreign ports. Denning et al. (MS) † recorded the finding of 16 dead specimens of this species during the period July, 1943, through December, 1944, by quarantine inspections of 10,757 aircraft arriving at Miami from foreign ports. Since 1931, quarantine regulations have required that such planes undergo insecticidal treatment either before landing in Miami or immediately thereafter to prevent introduction of obnoxious insects.

There have been very few studies made of the mosquitoes of southern Florida and the Keys, although intensive anopheline surveys were carried on around Army and Navy bases in this area during the recent war. Mulrennan et al. (1945) and Welch (1945) reported the finding of an adult female of *Anopheles (Nyssorhynchus)* sp., probably *albimanus,* in a spider web under a bridge near Morrison Field, West Palm Beach, on August 19, 1943. It was presumed by these writers that the specimen gained ingress to this country by airplane.

Mulrennan et al. (1945) and Carpenter et al. (1945) recorded the finding of a fourth instar larva of *A. albimanus* near the Army Air Base at Boca Raton, on May 16, 1944. An intensive search in this vicinity revealed no other representatives of this species. It was suggested by the former writer that this specimen was among the progeny of a female which was brought from Puerto Rico by airplane.

On January 13, 1946, the present writers discovered a fourth instar larva of *A. albimanus* on the northwestern side of Big Pine Key. An anopheline survey of the Florida Keys was then made during February by Raymond Krueger and Allan Obermuller, but no other specimens of *A. albimanus* were found.

* Acknowledgment is made of the assistance rendered by Mr. John A. Mulrennan, Director of the Bureau of Malaria Control, Florida State Board of Health; by Mr. G. H. Bradley, Chief of the Division of Entomology, Malaria Control in War Areas, U. S. Public Health Service; and by the Palm Beach County Anti-Mosquito Control District.

† Mulrennan, et al. (1945) included some of these data.

The climate of the Keys became increasingly arid during this period. The pool in which *A. albimanus* had been collected was dry and watered areas were found to be scarce.

The single larva of *A. albimanus* was taken in a brackish, roadside pool (pH 8.1) in association with *Culex atratus, C. elevator,* and *Uranotaenia lowii.* The pool was small, partially covered with algae, and shaded on the periphery with white mangrove *(Laguncularia racemosa)* and buttonwood *(Conocarpus erecta).*

Big Pine Key is situated at the northern end of the lower Florida Keys. The location is considerably distant from the nearest airport of entry into the United States. According to various natives consulted, there had been no commerce with Big Pine or adjoining Keys by boats from extra-continental limits during the war years.

That *A. albimanus* may become locally abundant in Florida was shown in Key West in 1904. It was not satisfactorily explained, however, that it was immediately controlled by man, since it would seem highly improbable that a species of mosquito which was established in Florida could have been exterminated by so simple an expedient as the hand collection of 131 adults. This would be particularly true of *A. albimanus,* since it is well known that in the Caribbean region only a small proportion of a given population of this species may be found in domestic resting places. The ecological conditions existing in the Florida Keys are very similar to those found in parts of the Greater Antilles, and excellent breeding conditions for *A. albimanus* similarly seem to be present. It has been noted, however, that in northern South America, the southern limit of this mosquito is reached without apparent reason (Rozeboom, 1941).

The fact that *A. albimanus* disappeared in Key West, although it obviously was breeding there, and that no further specimens were found following discovery of this species on Big Pine Key, even though breeding was demonstrated, indicates that it is very difficult for this species to maintain itself in large numbers in the Florida Keys. The fact that no further specimens were found at West Palm Beach or Boca Raton, even though breeding was demonstrated in the latter case, indicates that it is similarly difficult for this species to maintain itself in peninsular Florida. This evidence tends to minimize fear of the introduction of *A. albimanus* into Florida.

The recent finding of single specimens of *A. albimanus* at West Palm Beach and Boca Raton may be explained on the basis of chance introduction. The finding of a specimen on Big Pine Key, however, leads the writers to believe that the species possibly is endemic to the Florida Keys where conditions are such that it maintains itself only in erratic and extremely limited numbers.

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PSOROPHORA PYGMAEA (THEOBALD), AN EXOTIC MOSQUITO NOW ESTABLISHED IN FLORIDA [1]

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Psorophora pygmaea (Theobald) has been reported twice from Key West, Florida; August, 1901, A. Busch, 4 specimens, and April 1–3, 1903, D. A. Schwarz, 6 specimens. These specimens were described as *Culex nanus* Coquilett, Can. Ent., *35*, p. 256, 1903. The U. S. National Museum also has a series of specimens collected by Sargent Mead at Key West: 5 specimens, June 13, 1924, and 25 specimens, October 3, 1924 (unpublished records) which show that the species either has persisted at Key West or is being repeatedly introduced. The West Indies is the normal habitat of this species.

That this mosquito may now be established in south Florida is indicated by the capture of a series of specimens in a light trap operated by the Public Health Service at the U. S. Quarantine Station, Fisher's Island, Miami Beach, Florida. This series is as follows: On June 2–3, 1946 (two nights' collection), 23♀♀; June 14, 1♀; June 15, 1♀; June 16–17, 6♀♀; June 18, 1♀; June 19, 1♀; June 20, 2♀♀; July 26–27, 1♀; July 28–31, 1♀; a total of 37 specimens, all females.

Several thorough surveys of Fisher's Island were made during this period but the breeding places or even any places which appeared suspect could not be found. The neighboring parts of Miami Beach across the channel are populated and no *Psorophora* breeding places could be found. The mainland is rather distant and is also well populated. By a process of elimination, therefore, Virginia Key and Biscayne Key, to the immediate south of Fisher's Island, are regarded as the most likely breeding places. These islands are wild and inaccessible, and probably have numerous places suitable for *Psorophora* breeding. The absence of males in the catches supports the view that the breeding places are at some distance from the light trap.

The manner of introduction of this species is a matter of speculation. *Psorophora pygmaea* is a frequent hitch-hiker aboard planes arriving at Miami from the West Indies. However, the tight insect quarantine maintained at Miami, which includes spraying both in flight and after landing; the distance between the airports and Fisher's Island; and the fact that light traps in the vicinity of the airports have remained negative in regard to *P. pygmaea,* tend to preclude any argument that the species has been recently implanted by plane. The establishment of the species could well be the result of the original implantation at Key West, the species having gradually spread unnoticed northward through the Florida Keys.

Psorophora pygmaea fortunately is of no medical significance. Nevertheless, its establishment in Florida once more emphasizes the need for adequate insect quarantine backed up by thorough entomological surveillance.

[1] From the Foreign Quarantine Division, Bureau of Medical Services, U. S. Public Health Service.

BANISHING BUG BITES

C. A. SETTERSTROM
Carbide and Carbon Chemicals Corporation, New York, N. Y.

Civilian sales of insect repellent have reached an all time high this season because the insect-conscious public likes the new highly effective colorless and almost odorless liquids which are rubbed on the skin to keep away mosquitoes, flies, gnats, chiggers and other biting pests.

Before the war, insect repellents constituted a steadily growing but modest business. New specially designed chemicals were just beginning to replace the relatively ineffective citronella compositions. During the war, the chemical industry supplied the Army and Navy with over one hundred and fifty million two-ounce bottles of synthetic organic repellents—new military weapons against disease-bearing and annoying pests. The post-war civilian interest in repellents has been stimulated by the homecoming veteran who used repellents in the service, by the DDT publicity which has made the public "insect conscious," by the publicized research activities of leading State and Federal scientific laboratories, and by increased competitive activities of old and new manufacturers in the field. But the most important reason for continued civilian purchases is consumer satisfaction with the new repellents, one of which will not even attack milady's fingernail lacquer or other common plastics. The modern insect repellent is another triumph of chemical ingenuity.

THE "APPROVED" REPELLENTS

The joint Army-Navy specification on insect repellents lists "6–12," "Indalone," dimethyl phthalate and mixtures of the three. The United States Department of Agriculture has just issued a bulletin based on data from their Orlando Laboratories which reads in part as follows:

"The following available repellents are effective and safe when used individually or in combination: Dimethyl phthalate, Dimethyl Carbate (cis-bicyclo 2,2,1–5–heptene–2,3–dicarboxylic acid, dimethyl ester), Indalone (*n*–butyl mesityl oxide oxalate), and Rutgers 6–12 (2–ethyl–1,3–hexanediol).

"These chemicals vary greatly in their effectiveness against different insects and on different individuals. Certain materials which are satisfactory against some species may fail to repel others."

The report then recommends several mixtures of these repellents as being more effective against a wider range of insect species and on more individuals than any one of the chemicals when used alone.

Each of the repellents and each of the mixtures has advantages and disadvantages, so the choice of the best one is a matter of judgment and dependent upon the definition of "best."

"Indalone" is the most effective repellent against biting stable flies but among the least effective against mosquitoes. In the presence of ultra-violet light, it dimerizes to produce an ineffective solid which crystallizes on the skin. "Indalone" is also subject to hydrolysis, is light yellow to reddish brown in color and possesses a characteristic odor unpleasant to many. It is a solvent for nitrocellulose and other resins.

Dimethyl phthalate is markedly inferior to "6–12" against nuisance mosquitoes and many anopheline species, although it is the most effective against the *Anopheles quadrimaculatus* mosquito. This malaria carrier constitutes about 5 per cent of the total mosquito population of this country. All the approved repellents are about equally effective against chiggers but dimethyl phthalate is a preferred clothing impregnant because it is less soluble in water. Dimethyl phthalate, un-

fortunately, is an excellent solvent for nitrocellulose and many other resins.

Dimethyl "Carbate" (the dimethyl ester of "Carbic" Anhydride) ("Dimelone") is the newcomer to the Orlando list, and no detailed field data on repellency are available. It is a nitrocellulose solvent, has a characteristic musty odor, and is a colorless crystalline solid in purified form. Limited laboratory tests indicate that it is about 80 per cent as long-lasting as "6–12" against nuisance mosquitoes. At least one producer has had difficulty in producing a toxicologically acceptable commercial product.

"6–12" is the longest lasting repellent against nuisance mosquitoes in this country and against malaria carriers present in the South Pacific. It is as effective against chiggers and black flies as any of the single repellents or mixtures, but it is not the longest lasting repellent against the *Anopheles quadrimaculatus* mosquito (a malaria carrier constituting about 5 per cent of the total mosquito population of this country), or against the biting stable fly, *Stomoxys calcitrans* (not a major pest of man but an injurious insect attacking horses and mules). Unlike all of the other compounds listed, "6–12" repellent is not a solvent for nitrocellulose and does not smear, soften or remove most women's nail lacquers. It is not a solvent for nylon, rayon, or "Vinylite" or "Lucite" plastics but it dissolves alcohol-soluble gums such as shellac. "6–12" repellent is colorless and practically odorless. Not one single case of skin irritation or dermatitis has been reported despite the use of many millions of bottles of this repellent—a remarkable record of safe use. When thoroughly applied, and especially when applied to clothes in addition to the skin, "6–12" offers some degree of distance repellency —it keeps the insect pests a few inches away from the body. None of the other repellents or repellent mixtures is as effective in this regard.

The various mixtures suffer from many of the disadvantages and do not retain all the advantages of the single components. None of the mixtures, for example, is as effective against New Jersey nuisance mosquitoes as "6–12." Mosquitoes, of course, are by far the most important and annoying of the insect pests. Many of the mixtures are colored or have an odor and all dissolve nitrocellulose and other resins. No difficulties with "Indalone" instability in the mixtures have been reported, but this may be because the ineffective dimer is soluble in dimethyl phthalate and does not crystallize.

WAR RESEARCH

The first intensive scientific attempt to discover and develop a practical, efficient, and acceptable personal repellent began at New Jersey State Experiment Station, Rutgers University, about eleven years ago under the immediate direction of Dr. Philip Granett. After careful study, Rutgers selected the yellow fever mosquito, *Aedes aegypti,* as their test insect because repellent times correlated well with field studies against New Jersey mosquitoes and because the species gave reproducible results and was easy to rear in the laboratory. When war with Japan became imminent, malaria became a major military problem and on recommendation of the Committee on Medical Research, an O.S.R.D. project was established at the Orlando laboratories of the Bureau of Entomology and Plant Quarantine of the Department of Agriculture. The Orlando group adopted the Rutgers' testing techniques, modified them for larger-scale operations, and added the malaria carrier, *Anopheles quadrimaculatus,* as a test species in the hope that it would provide a more accurate measure of repellency against the Pacific malaria carrier. During their research program, they tested over 8,000 compounds and thousands of additional mixtures.

While the phthalates had been known to be a moderately effective repellent against nuisance mosquitoes since 1929, they aroused no great interest until the Orlando Laboratories discovered that

dimethyl phthalate was more effective than either "6–12" or "Indalone" against the *Anopheles quadrimaculatus*. This fact, coupled with a claim of evidence of synergism and with the inability of the producers of "6–12" and "Indalone" to supply the huge repellent demands of the Armed Forces led to the adoption of the "6–2–2" Mixture containing six parts dimethyl phthalate, two parts of "Indalone" and two parts of ethylhexanediol. Later, when the Army and Navy demands slacked off, the approved repellent composition was modified to contain equal parts of the three repellents, a mixture called "1–1–1."

Actually, in the South Pacific, where malaria was of particular importance, it was discovered that "6–12" was far superior to dimethyl phthalate and to both of the mixtures in repelling the malaria-carrying mosquito.

SURPLUS STOCKS

Over eighty million two-ounce bottles of the Army and Navy repellent mixtures have been declared surplus and are being offered for sale by the War Assets Administration. The surplus stocks consist chiefly of the "6–2–2" mixtures with some "1–1–1" and possibly some very small quantities of straight "6–12," "Indalone" or dimethyl phthalate. Early termination of the Japanese war, and the rapid cleanup with DDT of mosquitoes on malarial islands were major reasons for the large volume of surplus material.

The Army and Navy mixtures were designed for military use and suffer in the civilian market when matched against the tailor-made civilian repellents. Characteristics such as odor, color, solvency for fingernail lacquers, absolute freedom from skin irritation and dermatitis are not as important in a repellent for military purposes as they are in one for civilian applications.

THE "NAVY" REPELLENTS

Within the past three years, the Naval Medical Research Institute has developed a series of insect repellent chemicals culminating in a mixture of seven parts of 2 phenyl cyclohexanol and three parts of 2 cyclohexyl cyclohexanol which has been designated as NMRI–448. This repellent has been found effective against several species of mosquitoes in tropical areas and is now being further field tested in various Naval units.

NMRI–448 has not, however, been approved by the Navy, purchased by the Navy, or used by the Navy except in limited test quantities. Limited field tests by Rutgers indicate that the mixtures now being sold, containing 60 per cent "448," are 50–60 per cent as long-lasting as "6–12" against Jersey salt marsh mosquitoes. "448" is colorless, a solvent for nitrocellulose, and has a slight phenol-like odor. Toxicological tests are incomplete.

FUTURE DEVELOPMENTS

The ideal repellent would be one which would act at a considerable distance so that material applied on the hand, for example, would protect the whole body, or a few ounces applied on one wall would keep all insects out of the room. Whether or not such a repellent will ever be developed is open to question; it may be impossible to secure a sufficient volatility for distant effect without sacrificing the long lasting properties of the repellent. Nevertheless, as the fundamental scientific research proceeds and as more is learned about the physiology of insects and of the mechanisms of repellency, it may be possible to design even better repellents than the products meeting with such success in the civilian market today.

This article has appeared also in *Chemical Industries*, 59(3), p. 474, Sept., 1946. "Vinylite," "Carbic" and "6–12" (six–twelve) are registered trade-marks of Carbide and Carbon Chemicals Corporation.

STUDIES ON FILARIASIS IN PAPUA, NEW GUINEA

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Preliminary investigations for this project were started during the months of November and December 1944 while stationed in the Milne Bay area. Upon returning to this area for the month of September 1945 the studies were completed, as far as the limited time permitted.

Evidence presented by previous workers indicated that filariasis in this area is caused by the nocturnal periodic form of *Wuchereria bancrofti,* with its main vector being *Anopheles punctulatus moluccensis.* The existence of the nocturnal periodic form was established by F. Fulleborn in 1908. Observations of Backhouse (1) here and in the Mandated Territory of New Guinea concerned four thousand pre-war Europeans and, except for rare cases of lymphangitis of unknown origin, no clinical or laboratory manifestations of filariasis were observed.

The purpose of these studies was to establish the filarial index among the native population and to further establish or confirm the previous works on the nocturnal periodicity of *Wuchereria bancrofti,* with its possible relationship to military personnel in the adjacent areas. Dissections were made to compile data for some of the possible vectors of filariasis in this area. With the information presented by Backhouse of the apparent lack of filariasis among the white population, observations were made to verify this apparent negative condition.

It was further established by this study that the disease of filariasis is attributed to the presence of adolescent or adult *Wuchereria bancrofti* in the tissue of man and is of the nocturnal periodic form; that within the Papua area of New Guinea filariasis is endemic.

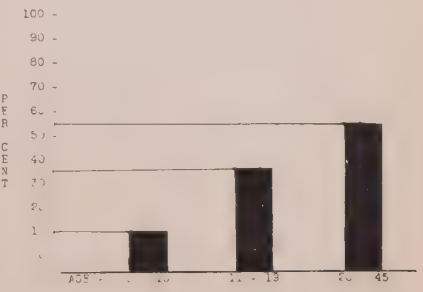
By the thick blood smear technique, it was demonstrated that from 35–55 per cent of the native population harbor the microfilariae in the peripheral circulation.

To ascertain the existence of the nocturnal periodicity of *W. bancrofti,* blood smears were taken on the same 200 natives at 1300, 2000, and 2330 hours. In addition to the data supplied in Table 1, it should be noted that all persons positive at 2000 were positive at 2330. Those who were positive for microfilariae at 2330 only, had light infections consisting of 3–5 microfilariae per slide, whereas those who were positive at 2000 exhibited 35–40 microfilariae per smear. All smears, as nearly as possible, were made of uniform size (1.5 cm. in diameter); however, it is realized that some were not uniform. The 2 per cent infection which was indicated at 1300 showed a tremendous increase in the number of parasites per smear at 2000. At no time was it evident that the ratio between the sexes varied. The age group which showed the highest rate of infection was that of 20–45 years. Table 2 tabulates the results of the in-

Table 1. Circulating Microfilariae Found at Specified Time Intervals.

Time	Total No. Slides	Positive Slides	Per Cent Positive
1300	200	4	2%
2000	200	70	35%
2330	200	102	51%

Table 2. Graphic Representation of Microfilariae as to Age Groups.



vestigation of *W. bancrofti* in the various age groups.

In spite of the high microfilarial index, the incidence of clinical manifestations of recurrent lymphangitis-lymphadenitis was, as a whole, surprisingly low. The most advanced elephantoid condition never exhibited the tremendous enlargement common in the endemic areas of the non-periodic *W. bancrofti*. Inguinal enlargements were frequent, but not necessarily of filarial origin. In those cases involving the lower extremities, only the area between the ankle and knee was affected, and usually not advanced beyond the early stage. In approximately one-fourth of the natives showing clinical involvement of the lower extremities, microfilariae could not be demonstrated by blood smears.

Observations of thirty-five Europeans who have been in New Guinea from twelve to twenty-five years revealed no evidence of microfilariae by thick blood smears. Upon physical examination no clinical manifestations were evident. Past histories indicated an essentially negative aspect which agrees with the previous works of Backhouse. Nocturnal protection of whites compared with natives was much the same so far as mosquito protection was concerned. Houses for the whites had no screens, with large open spaced walls. Bed nets were used by the whites, which made the difference in protection for the two groups. Segregation of whites from natives here, in general, was the same. The "boy houses," in which the natives were quartered, were usually about 300–500 yards from the estate houses. There were no bed nets or other protection of any type from the mosquitoes in the "boy houses." This distance was not great enough to control the flight range of the mosquitoes investigated here.

EPIDEMIOLOGY

In 1944 Backhouse (1) was of the opinion that *Anopheles punctulatus moluccensis* * is the vector of filariasis in this area; working with Heydon (10) he found experimentally that *Aedes aegypti* and *A. scutellaris* were unsuited as vectors, while *Aedes (Finlaya) kochi* experimentally proved to be an efficient vector. Faust, 1939 (6), lists *Anopheles punctulatus* which is also listed by Strong (7) as being the vector in New Guinea. Byrd *et al.* (8) conclusively established *Aedes scutellaris*, var. *pseudoscutellaris* as the vector in Samoa of the non-periodic form of *W. bancrofti*.

Most of the mosquitoes taken for dissection were collected from the "boy houses" at the Sagarai Plantation. Each house contained approximately sixty natives whose rate of infection for microfilariae was 55 per cent with an average of 25 to 35 microfilariae per smear. The engorged females were collected in the evenings at 1930 to 2030 and in the mornings at 0500.

Investigation indicated that while *Aedes kochi* is an efficient vector experimentally, (10) it was not of importance in the field at this time, due to the almost complete absence either in the larval or adult forms. Only an occasional specimen was taken, agreeing with the work done by Avery (2) 1944. *Aedes scutellaris* was encountered occasionally during the first part of the study in 1944, but for the month of September, 1945, only two adult specimens were collected. From the work done by Byrd *et al.* (8) the feeding time for *A. scutellaris* var. *pseudoscutellaris* was approximately between 1600 and 1630 hours which would conflict with the nocturnal periodic form of *W. bancrofti*, which can not be demonstrated in any number until 1900–2000 hours in this area.

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* Knight, Bohart, and Bohart (3), 1944, list this as a subspecies of *A. farauti farauti* termed *A. farauti moluccensis*. Rozeboom and Knight (4), 1945, have treated the subspecies as a synonym of *farauti*. In this paper the old terminology as listed by Russell, Rozeboom, and Stone (5) is followed.

Of the mosquitoes dissected from these collections 15.4 per cent of all *Anopheles punctulatus moluccensis* proved to be infected. In some instances, these mosquitoes were infected with three distinct development stages, others with two. The majority, however, contained only a single infection. The presence of two or three developmental stages indicates that these mosquitoes seek blood meals after being infected. Specimens collected in native villages showed a filarial incidence of 13.5 per cent.

Culex quinquefasciatus showed a positive incidence of 1.7 per cent for the infective filaria. *Culex annulirostris* was taken occasionally and while some specimens were found harboring microfilariae in the abdomen, none of the infective stages was found in the thoracic muscles or head.

Table 3. Record of Dissections.

Species	No. Dissected	Positive for *Wuchereria bancrofti* No.	%
Anopheles punc. moluccensis	275	42	15.3
Culex quinquefasciatus	75	2	1.7
Culex annulirostris	50	0	0.0

Experimental infections with *Anopheles punctulatus moluccensis* had interesting results. Of the seventy-five *A. punctulatus moluccensis* used in this experiment, fifty survived beyond the fourteenth day. Experimentally the rate of infection for this species was 65.3 per cent (Table 4).

Table 4. Record of 75 *Anopheles punctulatus moluccensis* Experimentally Infected in the Laboratory.

Days After Infective Blood Meal	No. Dead	No. Killed	Number Determined Positive
4	4	0	3
9	6	8	8
10	2	0	1
11	2	0	1
14	3	0	2
15	0	20	15
17	0	15	11
18	5	10	8

Fifty *Culex quinquefasciatus* were used experimentally with an infective rate of 12.3 per cent.

Density of the mosquito population varied in certain areas. *Anopheles punctulatus moluccensis* as a whole, however, was rather constant. Using human bait, night collections were made with an average of fifty-five bites from *A. punctulatus moluccensis* per hour. *Culex quinquefasciatus* was more abundant at the plantation than in the surrounding native villages. The most abundant species in the villages was *Culex annulirostris*.

The area used for these studies (Sagarai Valley) provided excellent conditions for obtaining a natural index as to filarial and mosquito population because the native population and terrain were not affected by the military activities in any way. The natives from the Sagarai Estate used in this study were, for the most part, from the immediate surrounding area.

Results, both experimentally and in the field establish *Anopheles punctulatus moluccensis* as an efficient vector of filariasis in this area. *Culex quinquefasciatus* does not appear to be of importance. *Aedes kochi* may be of importance during certain times of the year as, from the observations of the writer and others, this species is found almost entirely in the axils of banana plants, which at the time of this work were, as a whole, entirely dry. During the last week of September due to heavy rains, an abundance of first instar larvae were collected from the axils of this plant just prior to the completion of the study. It was not determined that these were *Aedes kochi,* as the larvae were too young for determination.

Having established *Anopheles punctulatus moluccensis* as an efficient vector of filariasis and, added to this, the fact that this species is also responsible for a high percentage of malaria transmissions, the apparent negative filarial index among the white personnel is difficult to explain. Records of Base Hospital 13, up to December 1944, had no history of cases suspicious of recurrent lymphangitis lymphadenitis. Records of Naval Dispensary 167 further substantiate these results.

Among the theories advanced to explain this condition, mosquito control apparently has the most support. This may in part explain the negative condition among military personnel, but it does not appear satisfactory or complete. The Europeans observed by Backhouse and the ones examined during this study, make no effort for the control of the vector with the exception of mosquito nets, and many of these are improperly used. With the length of time that these people have been in a highly endemic area, it is logical to assume therefore, that repeated exposures have been had to filarial mosquitoes, and yet no evidence of filariasis has been confirmed. The evidence thus presented indicates that the theory of the "controlled vector" is not adequate, and that some factor, as yet not known, either in the epidemiology or physiology of the microfilariae in becoming established in the definitive host is more likely responsible.

CONCLUSIONS

1. Filariasis among the natives in this area is highly endemic and is caused by the nocturnal periodic form of *Wuchereria bancrofti.*

2. *Anopheles punctulatus moluccensis* is an efficient vector in this area while *Culex quinquefasciatus* is of no great importance.

3. Among the white population in this area no evidence of filariasis was demonstrated at any time.

4. There is no apparent danger of military personnel becoming infected with this disease in this area.

5. The negative filarial index among the white population is not adequately explained on the basis of mosquito control; it seems more likely that some factors as yet unknown in the epidemiology or physiology is responsible, which either retards or completely controls the development of the microfilariae of the nocturnal periodic form of *Wuchereria bancrofti* within this group of people.

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OCCURRENCE OF *ANOPHELES ATROPOS* IN JAMAICA, B. W. I.

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During an assignment in Jamaica, B. W. I., it was possible to make several collections of mosquitoes about the Island. During June, 1945, a single female *Anopheles atropos* Dyar and Knab was taken on Little Goat Island. Unsuccessful attempts were made to locate the larvae or other adults. Dr. R. B. Hill of the Rockefeller Foundation, then at Kingston, Jamaica, informed the writer that he had taken a specimen of *atropos* on the north coast of Jamaica.

Little Goat Island (see map) is located in Galleon Harbour on the south coast of Jamaica, a few miles west of Kingston Harbour. The island itself presents few breeding places other than coastal mangrove swamps, crab holes and artificial containers. However, there are nearby salt marshes, tidal marshes and a freshwater river. Tidal pools and rainwater pools are universal. Other mosquitoes taken at Little Goat Island were *Anopheles albimanus* Wied., *Culex bahamensis* D. & K., *Aedes sollicitans* Walk., *Aedes taeniorhynchus* Wied., and *Psorophora confinnis* (Lynch Arribalzaga).

From published records available it appears that this capture establishes a new record for the farthest southern appearance of *atropos*. Dr. H. D. Pratt, Senior Assistant Scientist, U.S.P.H.S., has checked the identity of the specimen and it has been deposited in the U. S. National Museum.

THE OCCURRENCE OF *MEGARHINUS RUTILUS* COQUILLETT IN S. E. FLORIDA

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According to current literature, *Megarhinus rutilus* occurs in Georgia, Florida, and South Carolina. Relatively little has been published on the biology of this species.

While searching for *Wyeomia vanduzeei* Dyar and Knab and *Wyeomia mitchellii* Theobald at Fort Lauderdale, Florida, larvae of *Megarhinus* Robineau-Desvoidy were taken in August, 1945,

from one of the bromeliads, *Tillandsia utriculata* Linn. A surprising number of these larvae and some pupae were found when additional trips were made during September and October. In October and November of 1945, *Megarhinus* larvae and pupae were collected in Palm Beach County by the authors and R. C. Ridgway. The larvae, which are predacious, were found associated with *Wyeomia vanduzeei* and *Wyeomia mitchellii*.

One female adult was collected at Boca Raton, Florida, while resting on one of the dog fennels, *Eupatorium capillifolium* Lam. Another of undetermined sex was seen on the same plant but was not captured.

From the various collections made, a total of 26 adults were reared. Of these, 14 were males and 12 were females. The males conformed to the description of *M. rutilus* given by Howard, Dyar and Knab in that the entire second segment of the front and middle tarsi were white scaled and the basal two thirds of the third segment of the front and middle tarsi were likewise white scaled. The coloration of the thoracic stripes, which was the character used for separating the females of *M. rutilus* from *M. septentrionalis,* may not be consistent. However, of the 12 females which were reared, all had bluish thoracic stripes which conforms with Howard, Dyar and Knab's description of *M. rutilus*. These 12 adult females were compared with 4 *M. septentrionalis* that were collected in Georgia and South Carolina. The only outstanding difference noted was that the *M. septentrionalis* possessed yellowish median and lateral thoracic stripes.

The associated skins of the larvae of the 26 adults were compared with *M. septentrionalis* larvae but no significant differences were found.

No significant differences could be found when the male terminalia of *M. rutalis* and *M. septentrionalis* were studied.

It was interesting to note that while in the process of collecting larvae of *M. rutilus,* the adults of *W. vanduzeei* and *W. mitchellii* appeared in numbers large enough to make collecting uncomfortable. Both species bit readily and would be a nuisance to anyone remaining in the immediate breeding area.

Available information indicates that the larvae of *M. rutilus* are to be found in tree holes. Although innumerable tree holes have been examined by the personnel of the Palm Beach County Anti-Mosquito District, no *Megarhinus* larvae have been taken from these places. The larvae of *Culex quinquefasciatus* Say, *C. nigripalpus* Theobald and *Aedes aegypti* Linn. were taken in small numbers from tree holes as compared to *Aedes triseriatus* Say, which were found abundantly. In this area it appears that breeding of *M. rutilus* is confined almost exclusively to the air plant *Tillandsia utriculata.* Other breeding places, however, may be found with the additional studies which are being made in determining this mosquito's life history and habits.

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ASSOCIATION NEWS

Report of the May 24–25, 1946 Meeting: Papers and Discussions, *continued*

SHOULD MOSQUITO COMMISSIONS UNDERTAKE OTHER INSECT CONTROL PROBLEMS REQUIRING COMMUNITY EFFORT?

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The question, "Should mosquito commissions undertake other insect control problems?", is like many other questions in that there are two sides, the pros and the cons. It is the aim of the writer to present the case as he sees it. No doubt many of you will disagree with the arguments set forth. Nevertheless, it is an honor to be invited by this association to discuss this very important and timely topic.

It is assumed that the term, "other insects" implies all species that have a nuisance value and those of medical importance but does not necessarily include the agricultural pests. In this discussion it is deemed advisable to consider the matter from the standpoint of prevailing conditions in our state, namely, New Jersey. The conditions existing in other states, and the organizations and facilities for similar work outside of New Jersey, are not known well enough by the writer for consideration in this paper. Again, many of you from other states may have conditions so different from those existing in New Jersey as to present logical cases in direct opposition to the points which are brought out below.

Why Mosquito Commissions Might Undertake Other Insect Control Problems Requiring Community Effort

(1) County-wide Organizations.

In New Jersey we now have 15 active county mosquito extermination commissions. Each of these commissions has well organized staffs, including the superintendent, in some cases executive secretaries, the necessary field foremen and a field force. Due to the long experience in mosquito control work in most counties the members of the working force know their county intimately. With the available maps, charts and data on the county it would be a very easy matter for the county commission to carry out the control operations, provided sufficient knowledge of the problem at hand were available to the county organization.

(2) Equipment.

Almost every commission in New Jersey has machinery and equipment which could be readily adapted to other insect control problems. The commissions have the trained personnel to maintain and operate this equipment.

(3) Other Aquatic Forms of Insects.

The personnel of the county mosquito extermination commission has a very broad knowledge of aquatic insect life due to its long experience in dealing with mosquito problems. The various gnats which breed in water and which are very close relatives of the mosquito can undoubtedly be controlled more easily and more economically by a mosquito commission than by any other government organization now available.

POSSIBLE REASONS WHY COUNTY MOSQUITO EXTERMINATION COMMISSIONS SHOULD NOT UNDERTAKE OTHER INSECT CONTROL PROBLEMS REQUIRING COMMUNITY EFFORT

(1) Mosquito Control, an Unfinished Job.

I am confident that my many friends from the various county mosquito extermination commissions in New Jersey will agree with me when I say that we still have mosquitoes to control in nearly every county in the State of New Jersey. This is no criticism of any man or any commission in New Jersey but does emphasize the magnitude of the mosquito problem. There is still much work to be done by all of the control agencies before we can live in complete comfort without being pestered by mosquitoes. I am afraid a considerable period of time will elapse before we have the mosquitoes eliminated in any county in the state. Everyone appreciates the biotic potential of the mosquito, and the habits of mosquitoes, and I believe we all agree that we will be doing a great service to the various counties and the state as a whole if we keep the mosquito population at a low level.

(2) The Dissimilarity Between Mosquitoes and Other Insects.

Insect control problems in general are very complex. Regardless of the insect, or I might add, the arthropod, which includes ticks and mites and others, we have the host plant or the host animal as well as the biological enemies of the species in question to consider. In the case of mosquitoes, and particularly of the larval stage, the question of the host is not important. However, other forms of animal life existing in the water, which we might consider as a host of mosquito larvae, have to be reckoned with in many cases. Within recent years considerable attention has been devoted to the control of the adult mosquito. We can cite the example of protecting outdoor gatherings against attack by adult mosquitoes. One of the first considerations is the question of the effect of the treatment on surrounding vegetation. We must also consider the effect of the toxicant and repellent on the human subjects as well as their clothing.

Everyone who has had any experience in the control of larval forms of mosquitoes soon realizes that the species of mosquitoes involved, with few exceptions, is of minor importance. All species of mosquitoes during their larval stage live in water with the exception of *Mansonia perturbans,* and a few others, and sooner or later must come to the surface of the water for air, thereby making it possible to destroy the larvae, regardless of the species, when they come to the surface of the water, with chemical substances.

Offhand, I do not know of any group of terrestrial insects or arthropods where all species have such a point in common. Another important factor to take into consideration is that many species of mosquitoes are capable of flying long distances. Few of the other insects or arthropods with which I believe mosquito commissions would be concerned ever travel such long distances, but instead, remain more or less in local areas. This, to me, indicates that each member of a field control unit would be required to know intimately all the details concerning the life history, seasonal history and habits of all species which the commission attempts to control. To properly indoctrinate each man on the force would require considerable time and effort on the part of the leaders.

(3) What Insects Should the Commission Undertake to Control?

Under the existing conditions a mosquito commission is working in accordance with a specific law. We must assume that before a commission undertakes to control other forms of insects a revision of the law would be necessary. As was pointed out above, all mosquitoes

breed in water and for the most part mosquito control agencies have been concerned only with the aquatic stage of the mosquito. In other words the mosquito control agencies have dealt with impounded water and flooded areas. For the most part in New Jersey these mosquito breeding areas are such that mosquito control operations can be carried out with very little interference with valuable crops, ornamental plants, etc. In other words, the mosquito breeding area might be considered as wasteland or a large part of public property. It would seem, therefore, that practically any insect problem other than mosquitoes would involve private property, such as the city and urban lots, and when we have to deal with all private citizens even in a localized area we immediately run into complications. Let us take the house fly as an example. House flies normally breed in garbage dumps, in and around animal shelters and the backyard refuse dump. The mosquito commission would encounter little difficulty in carrying out the necessary operation on garbage dumps but how about the private properties in the outlying areas around the city or municipality where the municipal ordinance permits the keeping of a cow, a flock of chickens or a pig? Also, we should consider the refuse in the backyards of many homes. Unless all such areas are cared for the fly control program would probably fail. Let us again assume that fly control be undertaken. In many instances, especially around city property, the owner would immediately put up the argument that he was more troubled with the eastern tent caterpillar crawling on the laundry hanging on the clothes line in the backyard, getting inside the house and destroying some prize ornamental plant, than he is about the house fly. The argument very quickly arises, if you are going to do something useful to the county, to the municipality or for the individual, why not take in a broader scope and control all of the insect problems. There are many other examples that could be cited but time and space do not permit. We must assume from the start that it would be impossible for a mosquito control agency to undertake the control of all insects in the area under their supervision. The question is, "What species should be considered in such a program?" The writer can visualize serious difficulty in getting adequate legislation when the insect control program is extended beyond the field of mosquitoes.

(4) Possible Interference with Other Agencies.

In New Jersey we have a number of agencies that are authorized by law to undertake insect control on a community or specific area basis. For example, we have the Bureau of Plant Industry of the State Department of Agriculture that is actively engaged in insect suppression work. However, the activities of this organization are confined chiefly to agricultural problems although in the case of the Dutch elm disease, which is caused by an organism which is disseminated by elm bark beetles, the Bureau of Plant Industry of the State Department of Agriculture is carrying out a program in municipalities as well as forest areas in suppressing this serious disease of our elms. The Bureau of Animal Industry is also authorized to suppress serious insect problems which might affect the animal industry in the State of New Jersey.

The State Department of Health is also authorized by law to engage in insect suppression work and is now actively so engaged. Mosquito control agencies, in New Jersey at least, cannot afford to try for legislation which would permit such agencies to engage in insect control work that would interfere with the activities of the health department.

The U. S. Public Health Service is another agency which has authority to carry out insect control operations where

it is deemed necessary and advisable for the protection of public health.

Another agency which does not carry out control operations but which does advise the individual on how to secure relief from insect problems is the agricultural extension service of the State College of Agriculture.

Last, but not necessarily least, is the commercial pest control operator. The pest control operators can be divided into two groups: (a) those that control insect problems within structures, such as houses, factories, warehouses, etc., and (b) those that carry on spray service for the control of insects attacking plants and animals. This phase of insect control has grown rapidly during the past ten years. Now that World War II is over, many servicemen who gained valuable experience in pest control through the various branches of the armed services are going into this type of work. If the pest control operator, regardless of the phase of work he undertakes, can do the job at a reasonable cost to the property owner it would be advisable to leave such activities as far as possible to private enterprise. We know of cases where pest control operators have sprayed large areas with weed killers to keep down vegetation for the benefit of individuals subject to hay fever. There are also instances where pest control operators have sprayed comparatively large areas to control ticks. The spray service organizations have sprayed large woodland areas for the control of such insects as normally attack forest and shade trees and ornamental plants. Many pest control operators are called on daily for control of the common house fly, fleas in the home, bedbugs, rodents and many other pests.

With all of these agencies and services now available at fairly reasonable costs to the property owner, just how far should county mosquito extermination commissions go in actually undertaking or advocating other insect control problems requiring community effort?

POSSIBLE COOPERATION BETWEEN MOSQUITO EXTERMINATION COMMISSIONS AND OTHER AGENCIES IN INSECT CONTROL PROBLEMS REQUIRING COMMUNITY EFFORT

An attempt has been made to present some facts and possibilities concerning possible activities of mosquito control agencies in endeavors other than those concerning mosquitoes. Mosquito control agencies can without a doubt play a very important part in community activities on a purely cooperative basis. As an outstanding example we might cite the cooperative project on malaria between the State Department of Health, the county mosquito extermination commission and the Department of Entomology of the New Jersey Agricultural Experiment Station. These agencies, especially the first two mentioned, are making real contributions. It would seem advisable, therefore, for the mosquito commissions in New Jersey to cooperate with any other state agency or county agency as far as possible. Let us suppose that there is some important insect problem that should be tackled on a community basis where the county mosquito extermination commission can play a part. Would it not be advisable to see first if the particular problem could not be handled according to existing laws where, for example, the State Department of Health or the State Department of Agriculture could contract with the county mosquito control agency to carry out certain phases of the control operations? This might be done without modifying the state mosquito laws in any way. Before the county mosquito extermination commissions attempt to revise the now existing laws so that such agencies would have the legal right to undertake other insect control problems requiring community effort it would certainly be advisable to take stock of the now existing agencies rather than taking the chance of upsetting the present mosquito control laws and lose out in the long run.

We have all had some experience in getting mosquito control commissions established in the various counties. One of the first prerequisites has been to educate the citizens of the county concerning the importance of mosquito control. The same procedure would probably be necessary in case of controlling other insects on a community or county-wide basis. The task would be difficult but not impossible.

Discussion

(Mr. Ruth called on Mr. Dorer.)

Mr. Dorer: In Virginia the Mosquito Commissions are under the State Department of Health. The State Department has funds appropriated to the Commissions to supplement their local appropriation and the Health Commissioner is Chairman of all the Commissions. The mosquito control work is under the Health Department. In addition to mosquitoes, from time to time other problems come up in connection with other insects. For example, the day before yesterday we were called on to do something about Rocky Mountain fever ticks. We did not know too much about the control of ticks and we used mosquito men to spray areas in the residential section with DDT. We hope it will do some good but we made it very plain that it was an experiment and we were not sure of the result. This demonstrates that when the Health Department gets another problem they call on us, and we use our force to help them. In the last eight months they have put rodent control under us. In our state we have typhus fever and the control of rats. Because there was no other appropriate division of the Health Department it seemed logical to put it under us. That's the way it's going in our state—any time they have any public health problems dealing with insects or rodents they call on us.

Mr. Williamson: The tick problem and the spotted fever problem were also brought to our attention. Our law seems to be ideally suited to reach out and take under control insects that require community action. By community action I mean insects that are infesting a large area. I do not mean roaches or bedbugs. These do not require community action. I think every mosquito commission means to expand its facilities. They are ideally set up, with trained personnel and require only additional funds. Our law was amended this past winter to allow us to approach the control of these other insects. Previous to the amendment our law specifically stated that the money appropriated could be spent only for mosquito work. Our law is so designed that we have entry on private property and there is no question of an owner prohibiting us from going on the property. If he suffers damage from our work he has recourse to the courts.

Personally I do not agree with Dr. Pepper in his report. Mosquito commissions are the ideal means to take on additional work. If they do not do so other units of government will be set up. It would be an extravagant procedure and duplication of effort; and eventually an organization would grow up that would absorb the mosquito commissions. As a mosquito control worker I prefer to absorb the other fellow than have the other fellow absorb me.

Mr. Sammis: As Mr. Williamson has said, if we do not give proper consideration to this idea we certainly are going to show that we are not at all open to advancement and that we are not capable of increasing our activities. But if we do become absorbed, which might possibly be the case, we may find ourselves doing other kinds of work rather than mosquito work to the absolute exclusion of mosquito work.

Dr. Pepper: I purposely laid out the program to start discussion. In referring to Mr. Williamson's argument, I think the strongest point that the mosquito commission can claim is that the mos-

quito is a community-wide and even a county-wide problem from the standpoint that we have many species of mosquitoes of which several may fly long distances. A tick moves only by crawling or being transported by some animal and we know there are cases in New Jersey where the individual property owners in urban sections have completely or nearly completely eradicated ticks from their property. A person could not free his property of mosquitoes due to their habits and this is the point that I am looking at. The question of whether or not mosquito commissions are going to be absorbed I think is on the fence. They can go either way. I can see where if we do not absorb somebody we might get absorbed by somebody. Regardless of which is which, it needs very deep and careful thinking and planning and not a fly-by-night or spur of the moment activity. I am trying to base my discussion around activities in New Jersey.

Mr. Williamson: I don't want Dr. Pepper to think I am arguing against him. Dr. Glasgow has information on migration of ticks in our locality. We do know they hitch-hike or walk. Another insect problem requiring possible community action is the invasion of the Japanese beetle. You cannot expect one man to control that insect on his small plot and give relief to the whole countryside. Someone must do the job on a community-wide or county-wide basis—not on a spot control basis. The commissions seem to have authority to do that.

Dr. Pepper: That's just one of the points I want to illustrate. In New Jersey our State Department of Agriculture has, over a 10-year period, had a Japanese beetle suppression program. The Japanese beetle is an agricultural pest and that is one of the things I had in mind when I said where are you going to draw the line. You probably do not have the organization in New York as we have in New Jersey. We had an active program on a sectional basis under the supervision of the State Department of Agriculture on Japanese beetle suppression. There are other problems and it is a case of where are you going to draw the line. I think we all agree that most of the mosquito control agencies are centered around controlling insects of a nuisance value or of medical importance. If you are going to undertake a control program on a community-wide effort you must first take into consideration where the money is coming from. As long as you keep it within the county and you can sell the freeholders on such a program, where they appropriate money and contract with the mosquito commissions to carry out the work, that may be one thing. If you put it on a state-wide basis and revise laws, what would happen in case of the State Department of Agriculture, the Bureau of Plant Industry, Animal Industry, Department of Health, Agricultural Extension Service and maybe the College of Agriculture and Experiment Station? They might all like to get a hand in it. I can see where it might be a real opportunity to work on a county level where you can sell your program to the appropriating body and contract with them to do the work without interfering with the present existing laws.

Dr. Glasgow: I have been very much interested in Dr. Pepper's balanced presentation of the problem and in the discussion that followed. It is a subject upon which I have done a lot of thinking. I used to teach medical entomology and since I came to New York I have been interested in the general subject. A few years ago, up to 1938, I collected photostatic copies of all mosquito laws passed by the states and territories of the United States. I hope sometime to review those laws and report on them. We have missed some of the important points in this discussion. Pest control assumes several aspects. There are those pests which are of strictly local importance, bedbugs

and fleas; agricultural pests are usually pests that do not move in numbers from farm to farm or garden to garden. The property owner can take care of his own problems. Another group of insect problems arises where insects move from area to area. Here control is essentially a community problem.

Mr. Williamson spoke of the record of spotted fever on Long Island. The first case of spotted fever was reported in 1912, with two in 1913. No other cases were reported until 1924. Since that time the disease has advanced progressively in the number of cases reported and in the area involved. Altogether there had been 82 cases and 16 deaths in one county by the end of 1944. No endemic cases have been reported except on Long Island. One of the explanations advanced has been that a group of ponies had been brought from Arizona to Long Island and it is suggested by some, whether true or not we cannot say, that these ponies brought in ticks with them. The ticks matured and spread the infection and the disease became established.

It seems that the responsibility of a commission might vary according to the pests and the occasions for pest control that might exist locally. There will be no idea of requiring the mosquito commissions to undertake the control of orchard pests. The orchardists will have to look after their own problems. Codling moth might fly from a neglected orchard to a well kept orchard but the hazard is not so great that it involves community action. As for the other agencies which might be involved, I cannot quite see a department assuming responsibility for the control of mosquitoes, black flies, and ticks and do it adequately for the entire state. It seems much better to have community action for pest control where you have a pest that can be controlled only by community action. It is best to have the control arise through local initiative, administered by local officials and financed by local taxes. That is the way it is done in the few counties in New York State where we have such commissions now and we are hoping next winter to have a law whereby any county, city, village or part thereof may organize as a pest abatement district. The law is patterned after the present laws now in force in California and in Utah.

I have just outlined a few of the problems that seem to me appropriate for consideration by the existing mosquito commissions. The commissions should be given power to do anything necessary and the individual property owners have recourse through the courts in case of damage.

Dr. Pepper: It has been demonstrated that you can control mosquitoes. I do not know that such has been the case with ticks. Let us assume that you undertake this tick control problem for five years and at the end of that time you still have your 16 cases of spotted fever per year. What is apt to happen?

Dr. Glasgow: The mosquito commission is an operating group, not a research group. There are agencies charged with responsibility of what will control mosquitoes and ticks. Your group at Rutgers has been doing a service in working out fundamentals of mosquito control. Commissions apply this work. They will not undertake tick control until the problem is presented to them. Dr. Collins and I are carrying on work with the State Department of Health. Last year we did some work in the tick area and we find that there is real promise of successful control. Dr. Smith and others of the Bureau of Entomology, working in the South, have found promise of effective tick control along somewhat similar lines as ours. We are going ahead and we are going to try to find something to control ticks. Mr. Williamson is going to be required by his own neighbors to control them as soon as we can tell him what to do. The search for control measures is not the problem of the county commission, that is the problem of the research agency.

NEWS AND NOTES

THE FLORIDA ANTI-MOSQUITO ASSOCIATION will hold its 1947 Annual Meeting in the Suwannee Hotel at St. Petersburg, Florida, April 27, 28, 29, and 30.

THE 34TH ANNUAL MEETING of the New Jersey Mosquito Extermination Association will be held at the Hotel Haddon Hall in Atlantic City, New Jersey, on April 2, 3, 4, 1947.

LIEUTENANT-COLONEL RALPH J. VAN DERWERKER. On April 19, 1946, Major Ralph J. Van Derwerker was promoted to the rank of Lieutenant-Colonel in the Public Health Service. He was transferred from the Regional Office in New York City on May 23rd, to Washington, D. C. In Washington, Colonel Van Derwerker is a Sanitary Engineer Consultant to the Federal Public Housing Authority, and is in charge of their various regional districts in the United States. His home address is 2005 Glen Ross Road, Silver Springs, Maryland, and his office address is the Federal Public Housing Department, Longfellow Building, M Street and Connecticut Avenue, N.W., Washington, D. C. J. W. SCOTT

DR. NEWELL GOOD, one of our interested members, who gave a talk in Washington at Hayden Farms, November, 1945, during the Association's inspection trip, and subsequently published it in MOSQUITO NEWS, is now on duty as an entomologist for UNRRA in the vicinity of Foo Chow, China. His address is: Major Newell Good, PHS—3135—USF China Theater, USPHS —APO 945, c/o Postmaster, San Francisco, California. His wife is sailing the first part of December to join him, so Newell will be away for some time; and we are sure he will welcome letters from any of his Association friends.

H. L. T.

LT. COMDR. WILLIAM J. PERRY, author of "The Disk Harrow—A Valuable Addition to Malaria Control Equipment," in the December, 1945, MOSQUITO NEWS, is now studying medicine at Duke University; his present address is 613 Tiona Avenue, Durham, N. C. After his tour of duty in the South Pacific, Commander Perry was attached to the Naval Medical Center in Bethesda, where he taught medical entomology.

H. L. T.

SALT LAKE CITY MOSQUITO ABATEMENT DISTRICT has purchased from the Federal Housing Authorities a house and an acre and a half of ground in the center of the most important mosquito producing area in the district. This property is located near the Municipal Airport and was used as a radio station by the Army. The house is modern and has office and storage facilities. The grounds are inclosed by a heavy net wire fence. The district has established headquarters at this location and has installed a repair shop, storage tanks, Gambusia pond, and is planning the construction of garages, storage sheds and other improvements.

D. M. REES

FIG. 1. Building and part of grounds purchased from the Federal Housing Authority by the Salt Lake City Mosquito Abatement District.

SALT LAKE CITY MOSQUITO ABATEMENT DISTRICT has purchased from the War Assets Administration three trucks and other surplus material and equipment including 10,000 gallons of 5 per cent thanite insecticide. Thanite (isobornyl ester of 3-thiocyanoacetic acid) 5 per cent is mixed with kerosene and was used by military agencies as an insect spray. This material was purchased for 12¢ a gallon and has been used very effectively with DDT and pyrethrins. It has proved especially satisfactory and economical as an agent for destroying adult mosquitoes in a concentration of 2.5 per cent thanite and 0.03 per cent pyrethrins. In this form it has been used to spray out-door premises before public gatherings.

D. M. REES

THE MAGNA MOSQUITO ABATEMENT DISTRICT was organized in July, 1946. This district includes the western part of Salt Lake County adjacent to the area now covered for mosquito control purposes by Salt Lake City. Some mosquito abatement work has been carried on in this area for a number of years by the Utah Copper Company, American Smelting and Refining Company and other associated industries. This work will now be expanded and consolidated into a legally organized district. This is the third district to be organized in the State of Utah.

D. M. REES

LASKER GROUP "OSCAR" AWARDED TO BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE. A Lasker Group Award was presented to the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, by the American Public Health Association, at the 1946 convention of public health workers held November 12, in Cleveland, Ohio. Engraved on the award, a silver replica of the famous statue "Winged Victory," are the words, "In recognition of distinguished service in the solution of problems involving the health and comfort of the armed forces, with particular references to insect-borne diseases."

Dr. F. C. Bishopp, Assistant Chief, In Charge of Research, of the Bureau of Entomology and Plant Quarantine, received the Award for the Bureau. Dr. Bishopp is a specialist in the field of medical entomology and he had the over-all direction of the research conducted by the Bureau for the benefit of the armed forces. Three Divisions of the Bureau carried on the research. Entomologists and chemists, working mainly at the Agricultural Research Center at Beltsville, Md., and at the Bureau's laboratory at Orlando, Fla., were responsible for the success of the research program.

The citation which accompanied the award states "Early in the war, the Bureau of Entomology and Plant Quarantine, at the request of the United States Army, undertook the discovery and development of methods to control insects responsible for spreading diseases of particular significance during wartime. Outstanding among these was the search for more effective and practical methods of controlling body lice (typhus) and . . . mosquitoes (malaria, yellow fever, dengue, filariasis, encephalitis, etc.). Specialists skilled in the identification of insects assisted the armed forces by the identification of thousands of . . . insects, mites, and ticks suspected of carrying diseases and by training military personnel. This was part of a program which involved the testing of some 10,000 compounds and the ultimate discovery and adoption of several, including the aerosol bomb, which has been of inestimable value in combatting malaria (and other insect-borne diseases). . . . The Bureau conducted basic experiments which resulted in the development of dimethyl phthalate and later benzyl benzoate . . . effective in high degree against the mite carriers of scrub typhus . . . undertook studies (on DDT) which were influential in its use in the prevention of epidemic typhus fever among our troops. . . . Equipment was devised by the Bureau for the dispersion of DDT insecticides to meet various field needs. . . . Not the least of the achievements of the Bureau has been . . . its research and control operations against insects of agricultural importance . . . helping to assure an adequate food supply for the armed forces and those behind the lines. The American Public Health Association cites these achievements of the Bureau of Entomology and Plant Quarantine as a notable contribution to the public health."

President Truman, in a letter dated November 7, 1946, regarding the Lasker Awards, stated, "We try to take care of our people who are ill, but the greater wisdom would be to bend our greater effort to keep them well by spending money to find not only the cure of disease, but its cause and prevention." It is, of course, more logical and more effective to control disease-carrying insects than to try to cure humans afetr the insects have caused their diseases.

G. J. HAEUSSLER
In Charge Insect Pest Survey
and Information

MR. H. SHERWOOD SHINN has been appointed head of the Sprayer Division of the Lofstrand Company, Silver Spring, Md. With a successful public utility operating and appliance merchandising background, Mr. Shinn leaves (after 4 years) the Research and Development Division, Office Chief of Engineers. While with the Engineers, Mr. Shinn directed the development of the 3-gal. knapsack Stainless Steel Insecticide Sprayer used by the Army throughout the world, during the war. With the coming of Mr. Shinn, the Lofstrand Company, manufacturers of quality glass washers for 16 years, will offer a complete line of high quality sprayers and dusters and will set up a large distributor and dealer organization throughout the world. Mr. Shinn is a graduate Electrical Engineer, holding two degrees from West Virginia University.

P. BRUCE BROCKWAY. As a contribution to MOSQUITO NEWS, the following letter could not be improved by "editing":

National Institute of Health
Bethesda 14, Maryland
September 30, 1946

Dr. Robert Glasgow
Editor MOSQUITO NEWS
Albany 1, N. Y.

Dear Dr. Glasgow:

I am submitting the following information so that you can extract whatever of it you wish for your News and Notes Section.

P. Bruce Brockway, a member of our Association, is the son of P. B. Brockway, M.D., Director of the Toledo Area Sanitary District. Brockway, Jr., was in the Navy where he served in the early years of the war in the Southwest Pacific area. His duties as a corpsman in one of the Malaria Control Units gave him extensive experience in mosquito work. I met him when he was attached to the staff of the Malariology lab. at the Naval Medical School. His knowledge of raising mosquitoes and their habits was remarkable—*C. pipiens* that wouldn't even live for me, went right over to his office and oviposited! However, that is by way of introduction. At present, he is an assistant on the Toledo project, and I asked him for some news about their progress so that we could tell the rest of the A.M.C.A. of his whereabouts, etc. I shall quote from his letter of September 25:

"As for the information of our control work in and around Toledo, I regret to say that we haven't done any control whatsoever this year. However, next year we will start on our control program. To give you a rather rapid but running story of what has happened since I last saw you in February, the Toledo Area Sanitary District employed Dr. Herbert A. Crandell as Entomologist and Supervisor for the District. We have worked together very well in coordinating the work to complete our survey of the District, which is approximately 150 square miles. We employed five field men, who were instructed and then placed in the field to gather this survey information. I might say that the survey has included everything from catch basins to large swamp areas.

"We haven't gone into the immediate control because the State Code, under which we are operating states that we can only go into control work after the completion of the survey, and the only way to get a complete survey is to leave control alone. . . . Sometime during the coming month our findings will be placed in the hands of the State Director of Health, Dr. R. E. Heering, and our sanitary engineer. After their approval we will then start the purchase of equipment for control."

Sincerely,

(Signed) HELEN LOUISE TREMBLEY

EDITORIAL SECTION

A PROPOSED SERVICE PROJECT— MEMBERS PLEASE COOPERATE

It has been suggested that a substantial part of an early number of MOSQUITO NEWS be devoted to a series of special articles, or to an assemblage of material (possibly extracts from already published articles) presented in popular form so as to be clearly understandable to the layman, and designed to provide answers to a majority of the questions asked by correspondents about DDT and its uses, with special reference to mosquito control. With such an assemblage of material brought together in one place, portions might be found more conveniently accessible than the original articles for quotation; or the entire section might be recommended to correspondents by Mosquito Control Commissions and others.

It has also been suggested that if this section of the projected special number were reprinted in pamphlet form and made available at a nominal price, its sale might result in an appreciable addition to the Permanent Fund of the Association.

Mr. Stage, President of the Association, is much interested in the very obvious service value of the project, and assures me that other officers of the Association and of the Bureau also regard it as a very desirable contribution.

Mr. Stage tells me, however, that any original articles contributed as such by federal employees would have to have official approval before being released for publication; and that this would delay their availability for about a month. Many others are subject to similar restrictions and delay.

Because of the short time now remaining before such a special number should go to press, therefore, it may seem better, at least for 1947, to adopt the "Digest" idea which has proven so popular in other fields (Readers' Digest, Science Digest, Magazine Digest, and the like), and to bring together an appropriate series of digests or reviews of, and abstracts from recent publications which, individually, would be accessible only with difficulty to the public, or even to many members of the Association.

It is our understanding that official approval of scientific contributions by federal employees and others subject to similar rules, is required only for original articles. If true, this requirement would not apply to digests of already published articles, including articles previously published (of course with official approval) by the authors of such abstracts themselves.

The following is a tentative plan for the proposed section of the projected special number, subject, of course, to modification as the work develops. Criticism, suggestions, citations of significant articles, photographs for illustrative material, and signed abstracts are needed urgently, and as promptly as possible. Please write to Miss Helen L. Trembley, Associate Entomologist, National Institute of Health, and Associate Editor in Charge of Reviews and Abstracts, MOSQUITO NEWS, Bethesda 14, Maryland, at once, if you have in mind a contribution for this special section, or any suggestion which might add to its usefulness.

TENTATIVE OUTLINE FOR DDT DIGEST

USES OF DDT FOR CONTROL OF MOSQUITOES AND SIMILAR PESTS

Answers to Questions Received by Mosquito Control Commissions

Digests of Contributions by Various Authors as Indicated

1. Facts and Fallacies About DDT.
2. Market Forms of DDT and How to Use Them (Illustrations?).

3. Equipment for Applying DDT (Illustrations needed).
4. Mosquitoes: Their Ecology, Their Economic Significance, and General Measures Available for Their Control (Illustrations needed).
5. Repellents.
6. Other Pests Requiring Community Action for Their Control (Illustrations needed).
7. Use of DDT for Control of Mosquito Larvae (Illustrations needed).
8. Use of DDT for Large Scale Control of Adult Mosquitoes, Black Flies, Punkies, Sand Flies, and the Like (Illustrations needed).
9. Use of DDT for Protection of Public Gatherings and the Like from Annoyance by Mosquitoes and Similar Pests (Illustrations needed).
10. Use of DDT for Control of Warehouse Pests.
11. Sprays, Aerosal Fogs, and Particle Size.
12. Use of DDT for Household Control of Mosquitoes, Flies, Fleas, Bedbugs, and Other Household Pests (Illustrations needed).
13. Use of DDT as an Indoor Residual Spray for Malaria Control (Illustrations needed).
14. Use of DDT as a Residual Spray for Control of Flies in Dairy Barns, and in Similar Situations (Illustrations needed).
15. Use of DDT to Protect Livestock from Injury or Annoyance of Insects and Related Pests (Illustrations needed).
16. Use of DDT for Local Control of the Tick Carrier of Rocky Mountain Spotted Fever, of Q Fever, and the Like.
17. DDT and Wildlife.
18. Legal and Administrative Problems Associated with the Suppression of Mosquitoes, and of Other Pests Requiring Community Action for Their Control.

COOPERATION REQUESTED

I am interested in obtaining reprints; copies of unpublished manuscripts; and results of, or observations made in connection with work on the biological control of mosquitoes.

I want to bring this information together in the form of annotated bibliographies.

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REVIEWS AND ABSTRACTS

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In recognition of the increased interest in Latin American countries in the work of the Association, MOSQUITO NEWS hopes to publish from time to time original articles in Spanish, as well as reviews, abstracts, and other appropriate items. In the present issue, the abstracts in Spanish follow the English abstracts from which they were translated.

We wish to acknowledge the cooperation of the several friends of the Association who have kindly aided in the work of translation.

A MALARIOLOGIST IN MANY LANDS. Marshall A. Barber. University of Kansas Press. Lawrence, Kansas, 1946. 158 pp.

In the foreword of this book, Dr. Paul F. Russell of the Rockefeller Foundation states that the total incidence of malaria is unknown, but that conservative estimates might be: "300,000,000 cases annually with 3,000,000 deaths directly due to this disease." Efforts to combat this grave situation have been made in "many lands" and Dr. Barber shares with the reader his experiences, both serious and humorous, as he describes his investigations in the United States, Central America, the West Indies, Philippine Islands, Malaya, Fiji, Equatorial Africa, Greek Macedonia, Cyprus, Turkey, Russia, Egypt, India, and Brazil.

The history of malaria in the Americas began, perhaps, with early exploration and colonization, when the disease may have been transported in the veins of Leif Ericson and his crew. Dr. Barber traces the history of the malady in the United States down through the years, and discusses the rise and fall in abundance of *Anopheles quadrimaculatus* and *A. maculipennis,* the chief malaria vectors. Although giving credit for improved conditions to anti-mosquito measures such as drainage and insecticides, he attributes the general decline in malaria to screens, quinine, and improved medical treatment. In the winters, Dr. Barber transferred his research southward to Central America and the West Indies, where *A. albimanus* was the dreaded malaria carrier.

In the Phillippines, where Dr. Barber worked from 1911 to 1915, there was much malaria, although Manila was comparatively free. *A. minimus* was the chief malaria vector in the islands. Malaya, a "tropical woodsy peninsula," was the scene of Dr. Barber's studies in 1915–1917. *A. maculatus,* living in clear, sunlit waters, was the principal vector in the hilly interior. These larvae caused much trouble by their ability to live in very shallow water; but control of these "semi-amphibious" *maculatus* was effected by planting vegetation to "shade-out" the larvae. In the coastal regions, *A. umbrosus* and *A. sundaicus* were the transmitters.

"The Arsenal of Malaria," or Equatorial Africa, occupied Dr. Barber's attention during 1929–1930. The focus of his work was that portion of West Africa lying below the Sahara Desert, where *A. gambiae* was the chief vector. Some plasmochin drug-testing was done in Liberia.

Greek Macedonia, a country seriously afflicted with malaria, was visited in 1932–1936, and interim trips were made to Cyprus, Turkey, and Soviet Russia. *A. elutus* was considered the most dangerous vector in Macedonia, and observations were made on its flight dispersion. In Cyprus the chief malaria vector was *A. superpictus.* The study of the varieties of *A. maculipennis* was of paramount interest during investigations in Russia during 1934. *A. elutus* was a vector in Southern Russia.

Dr. Barber went to Egypt in the summer of 1936. Work was concentrated in three areas: (1) the Valley of the Nile, where *A. pharoensis* was the chief malaria vector; (2) the Suez Canal Zone, where *A. pharoensis* and *A. sergenti* were present, and both probably vectors; and (3) the extensive Oasis of Siwa, where *A. sergenti* was perhaps the principal vector.

India was visited from January until November 1937. In the Poona region, the most dangerous and abundant mosquito was *A. culicifacies; A. stephensi* was a serious vector around Bombay and other sections. In Assam, *A. minimus* in the tea gardens was controlled by "shading-out" the larvae, as in Malaya.

In 1939, Dr. Barber journeyed to South America, and after investigating the status of malaria in Chile and Argentina, he went to Brazil to spend the summer of 1939 working on *gambiae*-borne malaria problems. According to the author: "The history of the invasion by *Anopheles gambiae* begins in 1930 with the discovery by Mr. Raymond Shannon, entomologist of the Foundation, of a small area at Natal, Brazil, infested by *Anopheles gambiae,* which Mr. Shannon early determined was the same *gambiae* as that long known in Equatorial Africa." Fast mail service by plane and ship recently inaugurated from Dakar, West Africa, was undoubtedly responsible for the transportation of the species. Malaria had been present in Brazil, but an efficient transmitter like *gambiae* had until then been lacking. After a series of devastating epidemics had occurred, the government of Brazil and the Rockefeller Foundation initiated an anti-*gambiae* campaign in 1939. Paris green was used against the larvae and pyrethrum sprays against adults in shelters; and by 1941 the disease had been eradicated from the known infested area.

In concluding his narrative, Dr. Barber discusses the future of malaria and mosquito control, and recommends a combination of anti-malaria measures and public education.

H. L. T.

UN MALARIOLOGO EN MUCHOS PAISES. Marshall A. Barber. University of Kansas Press. Lawrence, Kansas, 1946. 158 páginas.

En el prefacio de este libro, el Dr. Paul F. Russell, de la Fundación Rockefeller, declara que la incidencia total del paludismo es desconocida, pero que según cálculos moderados podría ser de "300,000,000 casos anuales y el total de las muertes que causa directamente la enfermedad podría ser 3,000,000." Se han hecho esfuerzos en "muchas tierras" para combatir esta situación tan grave, y el Dr. Barber relata al lector sus experiencias, tanto las serias como las jocosas, al describir sus investigaciones en los Estados Unidos, la América Central, las Antillas, Islas Filipinas, la Península Malaya, Viti, la Africa Ecuatorial, la Macedonia Griega, Chipre, Turquía, Rusia, Egipto, India y Brasil.

La historia del paludismo en las Américas comenzó tal vez con las primeras exploraciones y colonizaciones, cuando la enfermedad puede haberse transportado en las venas de Leif Ericson y sus tripulantes. El Dr. Barber traza la historia de la enfermedad en los Estados Unidos en el transcurso de los años, y comenta sobre las fluctuaciones en la abundancia de *Anopheles quadrimaculatus* y *A. maculipennis,* los vectores principales del paludismo. Aunque reconoce que las medidas tomadas para combatir los mosquitos, tales como drenaje e insecticidas, han mejorado las condiciones, el autor atribuye la disminución general del paludismo al uso de la tela metálica, quinina y a la mejora en el tratamiento médico. Durante los inviernos, el Dr. Barber proseguía sus investigaciones en los paises cálidos de la América Central y las Antillas, donde el *A. albimanus* era el vector del paludismo que se temía.

En las Filipinas, donde el Dr. Barber trabajó de 1911 a 1915, había mucho paludismo, aunque Manila estaba relativamente libre de la enfermedad. El *A. minimus* era el vector principal del paludismo en las Islas. La Península de Malaca, "una región tropical selvosa," fué el terreno de los estudios del Dr. Barber de 1915 a 1917. El *A. maculatus,* que vive en las aguas claras y asoleadas, era el vector principal en el interior montañoso. Estas larvas causaron muchas dificultades debido a su facultad de vivir en aguas de muy poca profundidad, pero se pudo combatir con éxito estos *maculatus* "semianfibios," plantando vegetación que con su sombra destruía las larvas. En las regiones de la costa, el *A. umbrosus* y el *A. sundaicus* eran los transmisores.

"El Arsenal del Paludismo," o sea, el Africa Ecuatorial, mereció la atención del Dr. Barber durante los años 1929 y 1930. El terreno principal de sus trabajos era aquella parte del Africa Occidental que está situada al sur del Desierto de Sáhara, donde el *A. gambiae* era el vector principal. En Liberia, se hicieron algunas pruebas de los efectos terapeúticos de la plasmoquina.

La Macedonia Griega, región que sufre muchísimo del paludismo, fué visitada entre los años 1932 y 1936, y en los mismos años se hicieron viajes a Chipre, Turquía, y la Rusia Soviética. El *A. elutus* fué considerado el vector más peligroso en Macedonia, y se hicieron observaciones de su dispersión por el vuelo. En Chipre, el vector principal del paludismo fué el *A. superpictus.* El estudio de las variedades de *A. maculipennis* fué de principal interés durante las investigaciones en Rusia en el curso del año 1934. El *A. elutus* era uno de los vectores en la parte sur de Rusia.

El Dr. Barber estuvo en Egipto en el verano de 1936. El trabajo fué concentrado en tres áreas: 1) el Valle del Nilo, donde el *A. pharoensis* era el vector principal de paludismo; 2) la Zona del Canal de Suez, donde el *A. pharoensis* y el *A. sergenti* estaban presentes, probablemente haciendo ambos el papel de vectores; y 3) la extensa Oasis de Siwa, donde el *A. sergenti* era tal vez el vector principal.

Se hizo una visita a India desde enero hasta noviembre de 1937. En la región Poona, el mosquito más peligroso y abundante era el *A. culicifacies;* el *A. stephensi* era un vector importante alrededor de Bombay y otras partes. En Asam, el *A. minimus* en las plantaciones de té fué dominado, "sombreando" las larvas tal como se hizo en la Península de Malaca.

En 1939, el Dr. Barber hizo un viaje a Sud América y, después de investigar las condiciones palúdicas en Chile y la Argentina, fué al Brasil donde pasó el verano de 1939 trabajando en los problemas del paludismo traído por los *A. gambiae.* Según el autor: "La historia de la invasión por el *Anopheles gambiae* principia en 1930 con el descubrimiento por el Sr. Raymond Shannon, entomólogo de la Fundación Rockefeller, de una área reducida en Natal, Brasil, que estaba infestada de *Anopheles gambiae,* el cual pronto fué clasificado por el señor Shannon como el mismo *gambiae* que hacía tanto se conocía en el Africa Ecuatorial." El servicio rápido de correos por aeroplano y vapor que hacía poco se había inaugurado desde Dakar, Africa Occidental, fué responsable indubitablemente por el transporte de la especie. Había existido el paludismo en el Brasil, pero había faltado hasta entonces un transmisor eficiente como el *gambiae.* Después de una serie de epidemias desoladoras, el gobierno del Brasil y la Fundación Rockefeller emprendieron una campaña anti-*gambiae* en 1939. Se emplearon el verde de París contra las larvas, y rociadas de pelitre contra los mosquitos adultos en albergues; ya para el año 1941 se había erradicado la especie de la área que se sabía estaba infestada.

En la parte final de su narración, el Dr.

Barber trata de la lucha futura contra el paludismo y los mosquitos, y recomienda una combinación de medidas antipalúdicas con la instrucción del público.

(Translation of a review by H. L. Trembley, National Institute of Health, U. S. Public Health Service, Bethesda, Md.)

EFFECT OF SHORT CONTACT WITH DDT RESIDUES ON *Anopheles Gambiae*. By Leo Kartman and Mario M. da Silveira. Jour. Ec. Entom. 39(3):356–359. June 1946.

Through a series of experiments, the authors have secured a preliminary answer to their questions about the actual length of contact with DDT in relation to its toxic and lethal effects on *Anopheles gambiae*. Experiments were carried out in a laboratory near Dakar, French West Africa. All tests in all groups were conducted on laboratory-bred females, except for four tests in which the mosquitoes were taken from native huts.

Individual mosquitoes were sucked into an aspirator tube (a glass tube 8" long by 10 mm. in diameter, fitted with a rubber bulb) which was coated with residues equal to a dosage of 125 mg. of DDT per square foot. Observations were recorded on 60-second, 30-second, and 5-second contacts. The 60-second contact was tested 17 times in 23 days, with an average of 29.4 mosquitoes per test and an average of 5.5 mosquitoes for check tests with untreated aspirator tubes. The 30-second contact was tested 11 times over a period of 18 days; an average of 46.6 mosquitoes per test and 9.4 per check were used. The 5-second contact was tested 10 times in 12 days, with an average of 50 mosquitoes per test and 9.5 per check. Death was assumed at that moment when prodding with a sharp instrument elicited no observable response in any part of the insect's body.

All mosquitoes were affected at between 80 and 90 minutes; with the majority of individuals showing toxic symptoms at between 10 and 30 minutes after short contact with DDT residues. The 60-second group showed 100 per cent mortality 9 hours after contact, and the 30-second group, 100 per cent mortality at between 10 and 24 hours. The 5-second group showed 97 per cent mortality at between 10 and 24 hours after contact. There was a general correlation between toxicity trends and mortality trends in all groups. The first tremors from contact with DDT were not enough to prevent the mosquitoes from taking a blood meal. However, within 1 to 2 hours, the intensity of syndromes induced by DDT-toxicity had increased quite rapidly causing the mosquitoes to be in no condition to feed. The reaction of the wild mosquitoes was identical with that of the laboratory-bred individuals. The data indicate that an extremely short contact with DDT residues is sufficient to cause the death of most *Anopheles gambiae* females within a period of 24 hours after exposure.

(Louise Goode, National Institute of Health, U. S. Public Health Service, Bethesda, Md.)

EL EFECTO EN LOS *Anopheles Gambiae* DE CONTACTOS CORTOS CON RESIDUOS DE DDT. Por Leo Kartman y Mario da Silveira. Jour. Ec. Entom. 39(3): 356–359. June 1946.

En el curso de una serie de experimentos, los autores han obtenido una contestación preliminar a sus preguntas acerca de la relación entre la duración del contacto con DDT y sus efectos tóxicos y letales en los *Anopheles gambiae*. Los experimentos fueron llevados a cabo en un laboratorio cerca de Dakar, Africa Occidental Francesa. Todos los ensayos en cada uno de los grupos fueron hechos con hembras criadas en el laboratorio, con la excepción de cuatro ensayos en los cuales los mosquitos se capturaron en chozas de indígenas.

Uno por uno los mosquitos fueron sorbidos en un tubo aspirador (tubo de vidrio 8" de largo por 10mm de diámetro, previsto de una pera de goma) las paredes interiores del cual fueron cubiertas con residuos equivalentes a una dosis de 125 mg. de DDT por pie cuadrado. Las observaciones fueron anotadas después de 60, 30, y 5 segundos de contacto. El contacto de 60 segundos fué probado 17 veces en el curso de 23 días, con un promedio de 29.4 mosquitos por prueba y un promedio de 5.5 mosquitos por prueba de control con tubos aspiradores que no habían sido tratados. El contacto de 30 segundos fué ensayado 11 veces durante un período de 18 días; un promedio de 46.6 mosquitos por prueba fueron usados, y 9.4 por prueba de control. El contacto de 5 segundos fué ensayado 10 veces en 12 días, con un promedio de 50 mosquitos por prueba, y 9.5 por prueba de control. Se consideró muerto el mosquito en el momento en que, al punzarlo con un instrumento puntiagudo, ya no se observaba más reacción en ninguna parte del cuerpo del insecto.

Todos los mosquitos sintieron los efectos dentro de 80 a 90 minutos, mostrando la mayoría de ellos síntomas tóxicos dentro de los 10 a 30 minutos después de corto contacto con residuos de DDT. El grupo de 60 segundos mostró una mortalidad de 100 por ciento a las 9 horas después del contacto, y el grupo de 30 segundos, 100 por ciento de mortalidad después del lapso de 10 a 24 horas. El grupo de 5 segundos mostró una mortalidad de 97 por ciento dentro de las 10 a 24 horas después del contacto. Había una correlación general entre las tendencias tóxicas y las mortales en todos los grupos. Los primeros tremores causados por el contacto con DDT no fueron suficientes para impedir que los mosquitos tomaran una ración de sangre. Sin embargo, dentro de una o dos horas, la intensidad de los síndromos producidos por la toxicidad del DDT había aumentado bastante

rápidamente para que los mosquitos ya no estuvieran en condiciones de comer. La reacción de los mosquitos silvestres era idéntica a la de los criados en el laboratorio. Los datos indican que un contacto sumamente corto con residuos de DDT es suficiente para causar la muerte de la mayor parte de las hembras de *Anopheles gambiae* dentro de un período de 24 horas después de estar expuestas a los mismos.

(Translation of a review by Louise Goode, National Institute of Health, U. S. Public Health Service, Bethesda, Md.)

THE TRANSMISSION OF *Plasmodium gallinaceum* BY *Aedes (Ochleratatus) lepidus*. W. Lobato Paraense. Memorias do Oswaldo Cruz 42(1): 81–84. February 1945.

Experimental transmission of *Plasmodium gallinaceum* to chicks in the laboratory of the Division of Endemiology has been carried on with *Aedes aegypti* during the past four years; but, because of the yellow fever danger in that part of Brazil, it was thought advisable to seek a substitute vector. Among the many mosquitoes furnished for study were some larvae from rock-holes. These were reared to the adult stage, found to be a new species, and subsequently described as *Aedes lepidus* Cerqueira and Paraense (Mem. Inst. Osw. Cruz 42(1):11–15).

Rearing procedures for the larvae were similar to those for *A. aegypti,* and immature forms were raised with ease. The adults, however, were reluctant to bite, and success in feeding blood-meals was attained only with individuals isolated in Borrel tubes. Even under these conditions, relatively few took blood, with a resulting small egg production. Six generations were reared before the author's absence led to the loss of the colony. Dr. Paraense, however, expressed the intention of procuring more material to continue biological and morphological investigations.

Transmission was effected with two groups of *A. lepidus*. The lots of the first group fed on highly infected chicks and showed 100 per cent infection in 50 samples. The oöcyst count was low, the highest being only 56. The second group fed on moderately infected chicks; 28 out of 50 mosquitoes dissected were positive. Transmission to chicks was accomplished through the bites of infected mosquitoes and by subcutaneous inoculation of a trituration of infected salivary glands. All chicks exposed were infected, and the course of the infection was similar to that transmitted by *A. aegypti*.—H. L. T.

THE MOSQUITOES OF JAPAN AND THEIR IMPORTANCE. Tsai-Yu Hsiao and Richard M. Bohart. NAVMED 1095, Bureau of Medicine and Surgery, Navy Dept. Washington, D. C. 44 pp., 27 illus., 58 refs.

Entomologists concerned with taxonomic problems of Oriental mosquitoes will welcome this review of the mosquitoes of the main Japanese Islands and the Bonin Islands. The original literature on the Japanese mosquitoes to a large extent has been unavailable to those unfamiliar with the Japanese language. This paper by Hsiao and Bohart summarizes for the English speaking entomologists the important knowledge that is available regarding the mosquitoes of this region.

Keys are presented to the adult females and fourth stage larvae. The authors were able to examine 35 of the 44 Japanese species; information concerning the remaining species was obtained from the literature. Following the keys, the species are listed, with notes on taxonomy, distribution, biology, and relation to disease. *Anopheles sinensis* Wiedemann is considered to be a species instead of a subspecies of *hyrcanus*. Evidence is presented which indicates that *Anopheles edwardsi* Yamada, 1924, is a synonym of *A. koreicus* Yamada and Watanabe, 1918, or at most a variety of this species. *A. edwardsi* is thought to be a cold water form.

The distribution and incidence of infection of the four mosquito-borne diseases of Japan are given, as well as the evidence incriminating the vector species. Filariasis is especially prevalent in the southernmost islands and the Ryukyus. The authors refer to Yamada's conclusions that *Aedes togoi, Culex pipiens pallens, C. vagans,* and *C. whitmorei* are especially susceptible to infection, and that *C. sinensis, C. tritaeniorhynchus* and *Anopheles sinensis* are less so. Japanese "B" encephalitis is widespread in Japan, with epidemics usually occurring during hot summer weather. Japanese workers have shown that *Culex pipiens pallens, C. tritaeniorhynchus,* and *Aedes togoi* can be infected, and the virus is even said to be capable of passing from generation to generation in *C. pipiens pallens*. Malaria is not a serious problem in Japan, although it is more common in the southern Ryukyus. The vector is *Anopheles sinensis*. Dengue is transmitted by *Aedes aegypti* and *A. albopictus* in the Japanese Islands. *A. aegypti* has not been found on the main islands, and here the disease appears to be carried by *A. albopictus*.

The authors refer to three cases of yellow fever which had been reported from Japan, but point out that they were probably not indigenous.

(Lloyd E. Rozeboom, Dept. of Parasitology, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.)

THE MOSQUITOES OF JAPAN AND THEIR MEDICAL IMPORTANCE. (LOS MOSQUITOS DEL JAPÓN Y SU IMPORTANCIA MÉDICA.) Por Tsai-Yu Hsiao y Richard M. Bohart. NAVMED 1095, Bureau of Medicine and Surgery, Navy Department, Washington, D. C., 44 pp., 27 illus., 58 refs.

Los entomólogos que se interesan en los problemas taxonómicos de los mosquitos del Lejano Oriente recibirán con agrado este estudio sobre los mosquitos en las principales islas del Japón y en las islas Bonín. En el original, gran parte de la literatura sobre los mosquitos japo-

neses ha sido inaccessible a cuantos no dominaban el idioma japonés. Este estudio por Hsiao y Bohart sintetiza en inglés para el uso de los entomólogos los importantes conocimientos disponibles sobre los mosquitos de estas regiones.

Presentan claves a las hembras adultas y a las larvas de la cuarta etapa. Los autores lograron examinar 35 de las 44 especies japonesas, tomándose de la literatura los datos referentes a las demás especies. A continuación de las claves, se da una lista de las especies, con anotaciones sobre su taxonomía, difusión, biología y relación a las enfermedades. El *Anopheles sinensis* Wiedemann lo consideran como una especie en lugar de mera subespecie del *hyracanus*. Se presentan indicaciones de que el *Anopheles edwardsi* Yamada, 1924, es un sinónimo del *A. koreicus* Yamada y Watanabe, 1918, o cuando más, una variedad de esta especie. Se cree que el *A. edwardsi* es una variedad que habita las regiones de las aguas frías.

Se presentan la difusión y la incidencia de infección de las cuatro enfermedades transmitidas por mosquitos en el Japón, como también los datos incriminatorios de las especies vectoras. La filariasis predomina sobre todo en las islas más meridionales y en las islas Riu-Kiu. Los autores se refieren a las conclusiones de Yamada al efecto de que los *Aëdes togoi, Culex pipiens pallens, C. vagans y C. whitmorei* son sumamente susceptibles a la infección, mientras que los *C. sinensis, C. tritaeniorhynchus* y *Anopheles sinensis* lo son en menor grado.

La encefalitis "B" japonesa se ha difundido por todo el Japón, con epidemias que ocurren generalmente durante el tiempo cálido del verano. Investigadores japoneses han demostrado que los *Culex pipiens pallens, C. tritaeniorhynchus* y *Aëdes togoi* son susceptibles a la infección, y hasta se dice que en el *C. pipiens pallens* el virus es capaz de pasar de generación en generación.

El paludismo no constituye un problema serio en el Japón, aunque es más común en la parte sur de las islas Riu-Kiu. El vector es el *Anopheles sinensis*.

El dengue es transmitido por los *Aëdes aegypti* y *A. albopictus* en las islas japonesas. No se ha podido encontrar el *A. aegypti* en las islas principales, en las cuales el transmisor de la enfermedad parece ser el *A. albopictus*.

Los autores hacen mención de tres casos de fiebre amarilla que habían sido denunciados en el Japón, pero señalan que éstos probablemente no sean autóctonas.

(Translation of a review by Lloyd E. Rozeboom, Johns Hopkins University.)

WINTER SURVIVAL OF *Aedes Aegypti* (L.) IN HOUSTON, TEX. Stephen P. Hatchett, United States Public Health, Service Reports 61(34): 1234–1244, 1946.

The study was inaugurated in order to learn the winter habits of *Aedes aegypti* (L.) in an area where the winter weather consists of warm days alternating with cold ones. The winter of 1944–45, during which the investigations were conducted, was an unusually mild one with only one day of freezing weather and a minimum temperature of 30° F. Approximately 10,000 eggs from laboratory-reared females were deposited on the sides of containers, on the water surface and on filter paper, and placed outdoors under various conditions during the period of study.

A 43.5 per cent hatch resulted from the group of eggs which was kept immersed throughout the winter. In a second group where the eggs were attached to the inner surface of the containers and water was supplied only by normal rainfall, the hatch was 28.4 per cent. In a third group the eggs were allowed to incubate 72 hours and then kept dry for several months. In this group a 21.4 per cent hatch was obtained. In all three groups the hatch was lower in fully exposed containers than in ones in partially protected areas. The number of eggs hatching at any one time was markedly affected by temperature. When the mean temperature was 70° F. or above, there was an acceleration in the hatching rate. Few eggs hatched when the temperature dropped below 50° F. A small number of eggs hatched 48 hours after being placed outdoors, while some did not hatch until 90 to 95 days of immersion had elapsed. The mean period of immersion before hatching was about 32 days. The period between hatching and emergence of adults ranged from 7 to 59 days, with most specimens taking 2 to 3 weeks. Larvae which had just hatched and mature larvae about to pupate, were particularly susceptible to low temperatures. Larvae were better able to survive cold weather where there was a layer of organic matter on the bottom of the container. In general, temperature had little effect on the duration of the pupal period which averaged about four days. During the entire season about half of the larvae under observation became adults. The majority of adults that emerged prior to February 15 died soon after emergence while most of the females appearing after this date lived at least long enough to mate, feed and oviposit.

A series of experiments was also performed to learn the effects of artificial cold on *A. aegypti* eggs. It was found that eggs that had been continuously wet since time of deposition, did not survive artificial cold of 26° F. when it lasted 24 hours or longer. However, 10 per cent of the eggs hatched that previously had been dry and were then immersed in cold water and frozen at this temperature for 24 hours. Approximately half of all eggs hatched that were previously exposed to artificial cold of 34° F. for 24 hours. (Ralph C. Barnes, S. A. Sanitarian (R), Communicable Disease Center, U. S. Public Health Service, Atlanta, Ga.)

SOBREVIVENCIA INVERNAL DEL *Aëdes Aegypti* (L.) EN HOUSTON, TEXAS. Stephen P. Hatchett, Servicio de Sanidad Pública de los Estados Unidos. Informes del Servicio 61(34):1234–1244, 1946.

Se emprendió el estudio para conocer los hábitos invernales del *Aedes aegypti* (L.) en una zona en que el invierno consiste alternativamente de días tibios y fríos. El invierno de 1944–45, en que se realizaron las investigaciones fué excepcionalmente benigno, con sólo un día de helada y temperatura mínima de 30° F. Se depositaron aproximadamente 10,000 huevos de hembras criadas en el laboratorio, en los recipientes laterales, sobre la superficie del agua y en papel-filtro, y se colocaron a la intemperie en distintas condiciones durante el período de estudio. Se obtuvo un desarrollo del 43.5 por ciento del grupo de huevos que se mantuvo sumergido en el agua durante el invierno. En unsegundo grupo en que los huevos se hallaban adheridos a la superficie interior de los recipientes y el agua era sólo la normal de lluvia, el nacimiento fué de 28.4 por ciento. En un tercer grupo se permitió incubar los huevos durante 72 horas, manteniéndose después en seco durante varios meses. En este grupo se obtuvo un nacimiento de 21.4 por ciento. En los tres grupos fué más bajo el nacimiento en los recipientes completamente expuestos que en los que contaban con zonas parcialmente protegidas. En todos los casos la temperatura afectó notablemente el nacimiento. Cuando la temperatura media era de 70° F. o más, se aceleraba la tasa de nacimiento, mientras que disminuía notablemente al bajar la temperatura de 50° F. Nació un pequeño número 48 horas después de haber colocado los huevos a la intemperie, mientras que algunos tardaron de 90 a 95 días después de la inmersión. El período medio de inmersión antes del nacimiento fué de 32 días. El período entre la incubación y la salida del adulto varió de 7 a 59 días, y en la mayoría de los especímenes tomó de 2 a 3 semanas. Las larvas recién incubadas y las próximas a convertirse en pupa, fueron especialmente susceptibles a las temperaturas bajas. Las larvas sobrevivían mejor al tiempo frío cuando había una capa de materia orgánica en el fondo del recipiente. En general, la temperatura tenía poco efecto sobre la duración del período de pupa que promedió unos cuatro días. Durante toda la estación aproximadamente la mitad de las larvas se convirtieron en adultos. La mayoría de los que salieron antes del 15 de febrero murieron poco después, mientras que la mayoría de las hembras que apareció después de esa fecha vivió por lo menos lo suficiente para acoplarse, alimentarse y ovopositar.

Se llevó también a cabo una series de experimentos a fin de conocer los efectos del frío artificial sobre los huevos de *A. aëgypti*. Se halló que los huevos expuestos constantemente a la humedad desde el tiempo de la deposición no sobrevivieron al frío artificial de 26° F. después de 24 horas o más. Sin embargo, incubó 10 por ciento de los huevos que se habían mantenido secos anteriormente y luego sumergidos en agua fría y helados a esa temperatura durante 24 horas. Aproximadamente incubó la mitad de los huevos previamente expuestos a frío artificial de 34° F. durante 24 horas.

(Translation of a review by Ralph C. Barnes.)

RAPID METHOD OF SIMULTANEOUS FIXATION AND SELECTIVE STAINING OF THE INTERNAL ORGANS OF *Culicidae*. Antonio Millares. Revista de Sanidad e Higiene Pública 22(3): 250–257. March 1946.

This article describes in detail the steps necessary for producing differentially stained posterior digestive tracts and reproductive organs of mosquitoes. Dissection technique is discussed and illustrated. According to the author, staining of the digestive tract results in a blue midgut, rose intestine, rose Malpighian tubules with pale blue nuclei and deep blue nucleoles, and violet, blue, and green rectal papillae. The stained reproductive organs show blue ovaries, bluish-black testicles, rose vas deferens, and deep blue seminal vesicles. Briefly, the steps to be followed are:

1. Extraction of organs in a saline solution (6.5 per 1,000). The author prefers this hypotonic sodium chloride solution, although some workers find isotonic saline or even distilled water satisfactory. The midgut should contain no blood.
2. Fixation and staining in a dilution of Giemsa liquid in pure methyl alcohol (2 drops of the former to 1 c.c. of the latter). The preparation should not be over five days old. Slides containing dissected organs should remain immersed in the solution for 30 minutes.
3. Decolorization with pure methyl alcohol.
4. Clearing and elimination of alcohol. Terpinol, a neutral substance, is used.
5. Mounting in cedar oil.
6. Sealing with wax of R. de Noyer.

The author says that this entire operation requires only 40 minutes.

There are three colored figures: (1) the internal organs of a male *Anopheles,* (2) the internal organs of a female *Culex,* and (3) the development of eggs in the ovaries of a female *Culex*.—H. L. T.

MALARIA IN WAR. By J. A. Sinton, Ulster Medical Journal 15(1):3–28, 1946.

In the Robert Campbell Oration, Brigadier J. A. Sinton outlines briefly the effect malaria has had on the fate of wars as well as on the world's history. In some detail he sums up the problem of mosquito control as applied particularly under war conditions. These include

(1) protection from mosquitoes such as repellents, nets, screening, selection of healthy camp sites; (2) DDT residual spraying of adults by airplanes and by spray guns in tents and other types of housing for soldiers; and (3) antilarval measures consisting of draining, filling, flooding, oiling, use of Paris green and DDT, and prevention of man-made and animal-made breeding places. He then launches into a discussion of the control of the malaria parasites. Such methods consist of two principal drugs—quinine and mepacrine. Although for over a century quinine has been the chief standby, Sinton states that from the experience gained in World War II, mepacrine for military purposes is superior to quinine in that it does not interfere with the mental and physical activities of troops, gives longer protection, can be easily tolerated in larger therapeutic doses, causes few undesirable effects over prolonged ingestion, and if continued for a month after leaving malarious areas, it radically cures all malignant (and probably many benign) tertian infections.

He points out that the control of malaria during the second World War was so stimulated that it may be possible by these new methods to exploit to an undreamed of extent, the great natural resources of the tropics for the benefit of all mankind.

(Helen Sollers, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.)

DDT, THE SYNTHETIC INSECTICIDE. By T. W. West and G. A. Campbell. London, 301 pp., 1946.

A valuable book on DDT has been written by these two English chemists who summarize the results of many experiments in various parts of the world. To this detailed treatise they have added much of their own research. They outline the history and development of this insecticide, discuss its toxicity, use in paints, textiles and paper, and its value in controlling numerous pests of man and animals.

In the chapter on mosquitoes DDT is compared with phenothiazine, pyrethrum, and Paris green. The employment of DDT in larvicidal oils, airplane sprays, as a dust, in emulsions, suspensions, and as a residual spray for adults is discussed. In one test in this chapter DDT and pyrethrum are compared as to their effectiveness against larvae and pupae of *Chaoborus punctipennis* Say which is termed a mosquito. Actually this species belong to the family Culicidae but it is a non-biting gnat and reference to it in this part of the book seems a little out of place.

This publication is a good reference work which anyone dealing with mosquitoes would want in his library.

"The Truth About DDT" is a 64-page booklet published by West and Campbell and is an abbreviated summary of the book. Many new pictures, however, are introduced in this publication.

(Helen Sollers, U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine.)

AN ANNOTATED BIBLIOGRAPHY OF PAPERS RELATING TO THE CONTROL OF MOSQUITOES BY THE USE OF FISH. By John B. Gerberich. American Midland Naturalist, vol. 36, no. 1, pp. 87–131. July 1946.

"Man's interest in the control of mosquitoes has increased greatly during the second world war. In large measure this is due to his numerous contacts with them in tropical areas. Various control measures have been tried. Of these probably the most permanent and cheapest mosquito control method is the use of fish. The natural habits of both fish and mosquito larvae must be taken into consideration in selecting a species of fish to be used for the destruction of larvae. The problem of attacking the varied species of *Anopheles* is complex. They are commonly found in pools containing much vegetation and may be almost completely hidden by the surroundings. Keeping in mind the habits of the larvae the fish used must be a species that will search for food not only in the shallow water but amid dense vegetation.

"In pools, ponds, swamps and other natural bodies of water an adequate supply of food and the breeding habits of the fish become very important points for consideration. For satisfactory control the fish used must breed rapidly in order that large numbers of them will be present at all times when larvae are apt to occur. Carnivorous fish are preferred to omnivorous feeders. Surface feeders are considered to be most satisfactory, although sun-perch and goldfish under some conditions may be effective. Indigenous fish as a rule are easier to maintain than imported fish.

"Dr. S. F. Hildebrand [1] states that many of the species used in containers at one time or another are utterly worthless in open bodies of water. Virtually any hardy sluggish fish is suitable for mosquito control in containers. In fact, herbivorous species are used with success in barrels and cisterns because they generally are sluggish and will not jump out of the containers. Little or no plant food being available, the vegetarians will feed on wiggle tails. The problem is altogether different in nature, for there any useful species must normally by choice feed on mosquito larvae.

"All available literature dealing with this subject published since Howard, Dyar and Knab's 'The Mosquitoes of North and Central America and the West Indies' up to and including 1942 has been reviewed. The comments given under the references are observations of the respective

[1] S. F. Hildebrand, Fish and Wildlife Service, U. S. National Museum.

authors in connection with fish as a controlling factor. Two hundred and ninety-eight articles are listed. A summary of the facts presented reveals that two hundred and sixteen species of fish have been used in the control of thirty-five species of mosquitoes in forty-one countries. The chief publications used as sources for titles are: 'Review of Applied Entomology, Series B,' and 'The Use of Fish for Mosquito Control' (Rockefeller Foundation, 1924)." (Author's introduction.)

This appears to be a fine job of bringing together in one place a summary of what has been done with fish, and may have the very beneficial effect of inspiring more work along that line. All of us who have been in mosquito control appreciate the great benefit we constantly receive as the result of fish activity, even though the control in nature is rarely 100 per cent complete, and even where Gambusia are not present. Yet there seems to be little information to rate the effectiveness of our native temperate zone fishes, and even less to indicat how they may be manipulated in a practicable way to our advantage! (An outstanding exception, of course, being the use since the days of Dr. John B. Smith of salt marsh minnows in connection with ditching, for mosquito control on the open marshes.)—T. D. M.

"INCIDENCE OF INSECT-BORNE DISEASES IN U. S. ARMY DURING WORLD WAR II"

(Copied from *Tropical Medicine News,* Vol. 3, No. 3 (June, 1946), p. 14, and there credited as follows: "Lt. Col. O. R. McCoy, M.C., Chief, Tropical Disease Control Branch, Office of the Surgeon General, United States Army, has supplied the above information which was scheduled to appear in the U. S. Army M. Bull., Mar., 1946.")

"Provisional statistical reports indicate the following incidence of insect-borne diseases during World War II (January, 1942, to August, 1945, inclusive) based upon figures for hospital admissions:

Disease	Cases	Rate per 1000 per year
Malaria	440,789	20.0
Dengue	82,392	3.7
Sandfly fever	12,228	0.5
Typhus fever (total)	7,269	0.3
Scrub typhus	6,803 (estimated)	
Endemic typhus in U. S.	402	
Epidemic typhus	61 (estimated)	
Filariasis (Wuchereria)	2,110	0.09
Leishmaniasis	344	0.02
Relapsing fever	241	0.01
Rocky Mountain spotted fever	60	0.003

"No cases of onchocerciasis, plague, trypanosomiasis, yellow fever or oroya fever were listed in the statistical reports. Two cases of *Trypanosoma cruzi* infections, however, are known to have occurred in soldiers in Panama.

"It should be noted that the number of cases of malaria given above includes hospital readmissions. Only 226 deaths from malaria were reported through June, 1945. All but six occurred overseas. Figures for the Army in the Philippine Islands prior to October, 1944, are not included because of the absence of records.

"The cases of filariasis reported resulted almost entirely from infections with *Wuchereria bancrofti* acquired on certain islands in the South Pacific early in the war. A few cases of infection acquired by men living in endemic areas prior to their military service are also included in the total."

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